AMERICAN ENGINEER AND RAILROAD JOURNAL.

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AN AMERICAN OBSERVER ABROAD.*

III.—English Track.

By Prof. W. F. M. Goss.

I had heard much of English railway track. Its rigidity, the high degree of perfection attained in its maintenance, and the attention bestowed on its embankments have been so frequently referred to by Americans who have traveled in England that I had concluded that in these, and doubtless in many other respects, I should find English track to be far superior to that with which I had been familiar. This conclusion, moreover, had from time to time been re-enforced, by direct statements which I have heard, concerning the inferiority of American track.

There probably was a time when the average English track was better than that of America, but I deem it no disparagement of English track to say that this condition belongs not to the present, but to the past. The fact is, that American roads have made such wonderful progress in track design and maintenance that the result has quite outstripped the popular estimate.

English track is of the chair-type. The rail is double-headed, and having no flange or base upon which to stand, it is held in position by cast-iron chairs which in turn are bolted, or secured by spiking to wooden cross-ties. Years ago, rails which had become worn on one head were reversed in the chairs, and thus made to give service on both heads, but the practice has been abandoned since the adoption of steel rails; and as the weight of rail has increased, there has been an unequal development of heads, the lower one retaining dimensions which I imagine are but little changed from those of the iron rail, while the upper one has become larger.

The chairs in which the rails are held consist of a base from which two lugs rise to a height nearly equal to that of the rail. The bottom of the chair between the lugs gives support to the lower head of the rail, and the face of the inside lug bears upon the web of the rail, an oak key or "track-wedge" driven between the outside lug and the rail serving to maintain the latter in contact with the inside lug. The "wedges" are straight, but the outside lug is set at an angle with the rail so that the wedge tightens as it is driven. Joints in the rail fall between two chairs, and are usually made with four-bolt splice-bars, the outside bar extending to the top of the rail.

The claim to greater rigidity appears to rest upon the use of the cast-iron chair. I make this statement because I was told in England that the chair was considered an element of rigidity and because I can find no other element to which superiority in this respect could possibly be ascribed. In the matter of ballasting, for example, I did not see in England anything which could approach in outward appearance the ballasting of hundreds of miles of road over which I have ridden in the United States. Where broken stone is employed it is often intermixed with other material, and is always laid with less uniformity than in the tracks of our better American roads. The ties, a most important element in giving rigidity to track, are more widely spaced than in American track, and the English rail cannot, I think, lay claim to superior stiffness.

Since, therefore, the claim for superior rigidity appears to rest in the use of the chair, some account of the manner in which this detail performs its function may be of interest. As a means for securing a good bearing on the tie, the chair is as good, but doubtless not better, than the tie plate common to American practice; as a fastening between rail and tie it has obvious defects. The movement of the rail under influence of temperature changes, and of passing trains, loosens the wedges which, on important curves, I am told, must be redriven every morning. The fact that in yards and about stations, one not infrequently sees wedges which have dropped completely out of the chair also justifies the belief that when apparently in place they are sometimes loose and hence of little effect. Moreover, the wedges are on the outside of the rail and even when they are well driven, it would seem that on curves, under the influence of heavy trains at speed, they must yield enough to allow some vibration in the rail. If this condition exists it would account in part for the bad riding of English carriages on curves.

These points, while briefly and incompletely stated, will be sufficient to show that the English rail-chair is an element permitting flexibility rather than tending toward rigidity. The truth is that the chair of to-day is an heritage from a period when conditions were quite different from those now existing, a fact which no one appreciates more fully than English railway men themselves, many of whom I am told look for the early introduction of "rails of the American section." The proposition, therefore, that the English track is more rigid than our own cannot, I think, be maintained. The reverse is true.

Whether the line and surface of rails are better preserved on English roads than on those of American roads, which are comparable with them, I cannot say, for an estimate based on experience in riding over the track is, in this case, unreliable on account of differences in the character of the equipment. Judging the result by the means at hand for securing it, it appears quite unlikely that the English standard of excellence is as high as that prescribed for first class track in America, for the American track has the advantage of better ballasting, more closely spaced ties, and an equally stiff and better supported rail.

Special work at crossings is in England generally far inferior to similar work at home, though in England such crossings are comparatively rare. The practice is to carry crossing-frogs and the rails in their vicinity on longitudinal stringers, the advantage of running long ties obliquely under such work either not being appreciated, or made difficult to obtain because of the use of the chair.

The English embankments are indeed more beautiful than the average embankment of America. First of all, the former have easier slopes and these better maintain their regularity of form. This is man's contribution to their beauty, all the rest is nature's work, for in England everything is green! Seeds thrown into the air seem to find there all the conditions necessary for their germination, and the embryo plants take hold wherever they chance to alight. The railway embank-

*For previous article see November issue, page 348.

ments have to be green; they cannot escape it. I saw them when all the landscape was not only fresh and green, but possessed a depth of color, the full beauty of which can only be appreciated by those who have seen an English landscape in early summer. It is enough to say of the embankments that they constitute no blemish in such a landscape. As a rule, no attempt is made to adorn them in an artistic way, either by the use of flowers or by the application of the lawn-mower, as is frequently done in America; but still, the advantage is with the English embankments. Their green sides harmonize so perfectly with the hedge-rows and the willow-fringed streams, that the presence of the iron way is only a slightly marked intrusion on a peaceful rural scene.

The structures along the right-of-way have often been spoken of in terms of highest admiration, because of their permanent character. Most of them were made years ago when no one could foresee the requirements of to-day's traffic. The platforms, tunnels and overhead bridges prescribe a clearance gauge which requires the cross-section of English trains to be smaller than that of any other country using standard gauge road. American roads with clearances which used to be considered very liberal are now working close to their limits, and beginning to wish for more room; and it must be that the English, working within very much narrower limits have long ago realized something of the handicap which is upon them. It would, in fact, appear, that the very element of permanency which characterizes these structures is a serious obstacle to the progress of the roads. Viewed in the light of American experience, it amounts in many cases to a species of over-designing.

It should be noted that whatever defects may exist in English track are due chiefly to the presence of details which have descended through a long series of years, which in their day have served a good purpose well, and which must now be given time to disappear. Moreover, English track is, generally speaking, good, and hence not deserving criticism. The sole purport of this letter is to deny the commonly alleged inferiority of American track.

To evidence already presented I would add that since this letter was outlined, I have seen enough of the tracks of Continental Europe to convince me that Americans will do their country but justice and will take to themselves nothing, but deserved credit, if they refrain from awarding the palm in the matter of track to any country save their own. I doubt whether the track exists which is better in its road-beds, or in the details of its structure, or in the degree of perfection attained in keeping the rails to line and grade, than that which reaches out over thousands of miles in the United States.

The application of power brakes and automatic couplers in this country, according to the latest report of the Interstate Commerce Commission, stands as follows: Out of a total of 9,956 passenger locomotives, 9,845, or practically all, are fitted with train brake apparatus, and out of a total of 33,595 passenger cars 33,149 were so equipped at the end of June, 1898. Of the passenger locomotives 5,105 had automatic couplers and 32,697 passenger cars were thus equipped. In freight service 19,414 out of a total of 20,627 locomotives had train brakes and 6,229 had automatic couplers. Out of 1,248,826 freight cars, 567,409 had train brakes and 851,533 had automatic couplers.

The number of railroads in the hands of receivers has decreased by 34 during the year ending June 30, 1898, which is covered by the latest report of the Interstate Commerce Commission. During that year 11 roads went into the hands of receivers and 45 were removed from their management. There was a decrease of 6,116.73 in the operated mileage of this class of roads.

LOCOMOTIVE DESIGN.*

By F. J. Cole, Mechanical Engineer, Rogers Locomotive Works.

Strength of Flat Surfaces in Boilers.

It is often desirable to know the theoretical as well as the actual elastic strength of flat plates to resist steam or water pressure, under conditions similar to those of their use in steam boilers, in order to calculate, or ascertain, with a reasonable degree of accuracy, the pressure per square inch which will permanently set or bulge a flat plate for a given thickness, material, distance apart of stays, etc.

The demand for heavy engines of great tractive power has necessitated the use of high steam pressures, so that few new locomotive boilers are built to carry less than 180 pounds per square inch, and pressures of 200, 210 and 220 pounds are the rule rather than the exception.

In considering the strength of flat plates in boilers carrying the latter pressures, it seems more desirable to estimate their elastic strength to resist bulging, and from this to select a suitable factor of safety, than to trust entirely to empirical considerations and merely add a little to the strength of previous work, built for lower pressures, which appears to be safe for those known conditions.

Probably the most exhaustive investigations into the strength of flat stayed surfaces and the holding power of screw stays in iron, steel and copper plates, was made by Messrs.

Steel Plate—Iron Staybolts.

Staybolt heads shaped, with a buttonhead set, to spherical segments.

Thickness of plate	3/8 inch
Distance from center to center of staybolts	4 inches
Diameter of staybolts outside of threads	1 inch
Diameter of staybolts inside of threads	9/16 inch
Diameter of staybolt heads at base	1¼ inches
Height of staybolt heads	7/16 inch
No. of threads on staybolts per inch	12
No. of threads left projecting to form head	5
Tensile strength of each staybolt	32,476 pounds

Greatest bulge and permanent set of plate at different pressures, measured at points between staybolts.

Pressure.	Bulge.	Set.	Remarks.
Pounds.	Inches.	Inches.	
500	0	0	The first leaks appeared around the four central staybolts at 1,600 pounds; at 1,700 pounds the heads stripped from these bolts, and the others were damaged as shown in the drawing.
700	0	0	
900	0	0	
1,100	1/32	0	
1,300	3/32	1/16	
1,500	9/32	9/32	
1,600	23/64	11/32	
1,700	—	13/32	

Sprague and Tower for the Bureau of Steam Engineering. The report was published by the United States Government Printing Office in 1879. The experiments on screw staybolts and flat plates were arranged to represent a section of a firebox, and to imitate as nearly as possible the actual conditions existing in a boiler. Fig. 1 shows the apparatus used in the experiments. The ring was 4 inches deep, 18 inches internal and 23 inches external diameters, arranged with bolts so that the plate to be tested could be secured to one side of this ring. Stay bolts spaced from 4 by 4 inches to 8 by 8-inch centers were screwed through the plates and riveted over. Water was then pumped in through the opening, A, and the pressure required to produce permanent set or "bulge" in the plates carefully noted.

Table No. 1 was compiled from these tests, and summarizes the results of that part of the experiments referred to which relates to the strength of flat stayed plates when used under conditions similar to those in locomotive boilers and fireboxes. The results are somewhat erratic, permanent set occurring in some cases at much lower, and in others at much higher pressures than might have been expected. This is particularly the case with the ¼-inch iron plates; the "set" occurred at 100 pounds, with 6 by 6-inch centers, and at 50 pounds with 7 by 7-inch centers. Probably if these tests

* For previous article see page 361.

TABLE No. 1.
U. S. Bureau of Steam Engineering, pressure in pounds per square inch to permanently set flat plates supported by staybolts.

Plates.		Center to center of staybolts.				
Thickness in inches.	Material.	4 x 4 in.	5 x 5 in.	6 x 6 in.	7 x 7 in.	8 x 8 in.
¼	Iron.	900	325	100	50	....
⅜	"	900	500	300	200	....
½	"	1,000	800	700	200	....
¼	Steel.	700	200	125	250	100
⅜	"	1,100	500	500	300	....
½	"	1,600	600	700	400	400
¼	Copper.	300	100	....	....	....
⅜	"	....	350	100	....	....
½	"	....	....	300	200	....

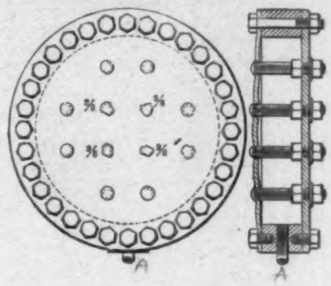


Fig. 1

had been repeated two or three times, many of the apparent inconsistencies would have disappeared in the average result. The staybolts used were nearly all 1-inch diameter in the bodies, with 1¼-inch diameter heads, formed like the segment of a sphere.

From an examination of the above table it will be noticed that the strength in a number of cases does not increase as the square of the thickness. Plates held rigidly at the edges in the manner described should apparently follow the same general laws as a rectangular beam firmly fixed at both ends and uniformly loaded, and the strength be proportionately greater than when merely supported at the ends or edges. (Figs. 2 and 3). The strength should also increase as the square of the thickness. It may be suggested, however, that when the plate is rigidly confined at the edges, either with or without stays, permanent set takes place by the stretching or pocketing of the plate between the staybolts. If a beam, made of material equally strong both in tension and compression, be merely supported, and not fixed at both ends, and loaded in the center, it will fail by compressing the fibers above and extending those below the neutral axis; therefore the beam will bend but will not increase in length. If it is firmly fixed at the end in a rigid support, it is evident that some lengthening of the beam must take place before it can take permanent set.

The following formula is suggested for flat stayed plates. While it observes the generally accepted and established laws regarding the thickness, it also gives average results closely agreeing with the foregoing experiments and tests:

$$S = 1.5 \frac{E\,t^2}{(d - a)^2}.$$

In which:

S = maximum stress to permanently set.

E = elastic limit of plate, about 32,000 pounds steel, 29,000 pounds iron.

t = thickness of plate.

d = center to center of stays.

a = diameter of head of stay.

Board of Trade (British) rules for flat plates:

$$P = \frac{C\,(T + 1)^2}{S - 6}.$$

P = working pressure per square inch.

S = surface supported in square inches.

T = thickness of plates in sixteenths of an inch.

C = constant as follows:

C = 112.5 for plates not exposed to heat or flames, stays fitted with nuts only.

C = 100 for plates when exposed to heat and flame and water in contact with the plates, and stays screwed into the plates and fitted with nuts.

C = 66 for plates exposed to heat or flame with water in contact with the plates; stays screwed into the plates with riveted heads.

The working pressures for firebox plates with riveted screw stays, by this rule, would be: C = 66.

For 5/16 plates.	4 in. centers of stays.	P = 237.
" " "	4¼ " " " "	" = 198.
" " "	4½ " " " "	" = 169.
" ⅜ "	4 " " " "	" = 323.
" " "	4¼ " " " "	" = 269.
" " "	4½ " " " "	" = 231.
" " "	4¾ " " " "	" = 196.
" " "	5 " " " "	" = 170.

The working pressure allowed on flat surfaces by the U. S. Board of Supervising Inspectors of Steam Vessels (rules issued in 1899) is determined by the following rule:

Plates 7/16 inch thick and under, for fireboxes.

Let P = working pressure.

C = constant = 112 for 7/16 plates and under.

C = constant = 120 for plates over 7/16 in thickness.

D = center to center of stays.

T = thickness for plate in sixteenths of an inch.

Then

$$P = \frac{T^2\,C}{D^2}.$$

Working Pressures Allowed on Flat Surfaces in Fireboxes, Screw Stays and Riveted Heads, Calculated from Data given by the U. S. Board of Supervising Inspectors for Steam Vessels.

$P = \frac{T^2C}{D^2}$ $C = 112.$

Centers of stays.	Thickness of plates.				
	5/16	11/32	⅜	13/32	7/16
3¾	199	241	286	336	390
3⅞	186	225	268	314	365
4	175	211	252	295	342
4¼	155	187	223	261	3·3
4½	138	167	199	233	271
4¾	124	150	179	209	243
5	112	135	161	189	219
5¼	102	123	146	171	199
5½	92	112	133	156	181
5¾	85	102	122	143	166
6	78	94	112	131	152

Provided the strain on stay or bolts does not exceed 6,000 pounds per square inch of section. On flat surfaces other than firebox, a constant of 140 is used, when the stays are screwed through and provided with nuts.

Working Pressure Allowed on Flat Surfaces other than Fireboxes, when Screw Staybolts with Nuts on the Outside and Inside of the plates are used. Calculated from data given by U. S Board of Supervising Inspectors for Steam Vessels.

$P = \frac{T^2\,C}{D^2}.$ $C = 140.$

Center of Stays.	Thickness of Plates.					
	5/16″	⅜″	7/16″	½″	9/16″	⅝″
4	218	315				
4¼	194	279				
4½	173	249				
4¾	155	223	304			
5	140	201	274			
5¼	....	....	248			
5½	....	....	226	296		
5¾	....	....	....	271		
6	....	....	....	249	315	
6¼	....	....	....	230	290	
6½	....	....	....	212	268	
6¾	....	....	....	196	249	307
7	....	....	....	183	231	285
7¼	....	....	....	170	216	266
7½	....	....	....	159	202	249
7¾	....	....	....	149	189	233
8	....	....	....	140	177	218
8¼	....	....	....	....	167	205
8½	....	....	....	....	157	193
8¾	....	....	....	....	....	182
9	....	....	....	....	....	172
9¼	....	....	....	....	....	163

Rules prescribed by the U. S. Board of Supervising Inspectors of Vessels.

Bumped Heads of Boilers.

"Pressure Allowed on Bumped Heads.—Multiply the thickness of the plate by one-sixth of the tensile strength, and divide by one-half of the radius to which head is bumped, which will give the pressure per square inch of steam allowed.

"Example.—On a bumped head 54 inches in diameter, T. S. 45,000 pounds, ¾ inch thick, bumped to a radius of 54 inches, pressure would be allowed as follows: T. S. 45,000 pounds, one sixth equals 75,000 pounds, which, multiplied by .75, the thickness, equals 5,625, which, divided by 27 inches, one-half the radius, equals 208.33 pounds pressure allowed. Where the circumferential seam in such head is double riveted to shell, which is entitled to an additional pressure there will be allowed 20 per cent. additional pressure on said head."

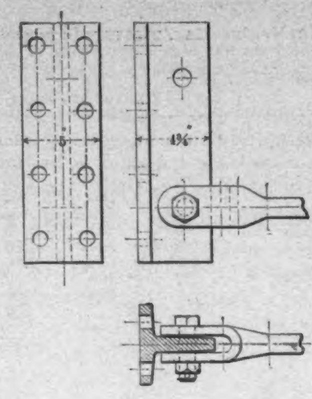


Fig. 5.

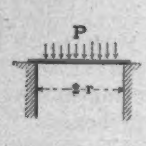


Fig. 2

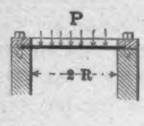


Fig. 3

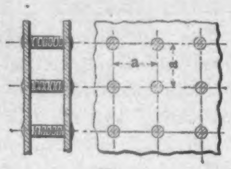


Fig. 4

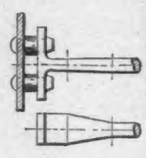


Fig. 6

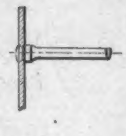


Fig. 7

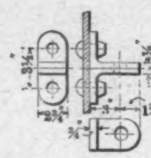


Fig. 8

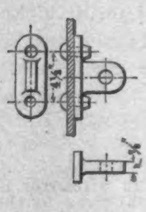


Fig. 9

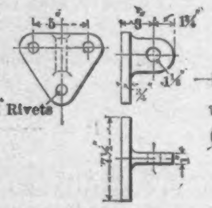


Fig. 10

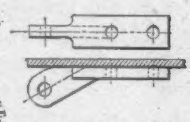


Fig. 11

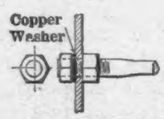


Fig. 13

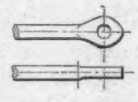


Fig. 12

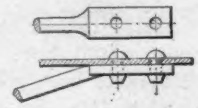


Fig. 14

"The pressure on unstayed flat heads, when made of stamped material, on steam drums or shells of boilers, when flanged and made of wrought iron or steel or of cast steel, shall be determined by the following rule:

"The thickness of plate in inches multiplied by one-sixth of its tensile strength in pounds, which product divided by the area of the head in square inches, multiplied by 0.09 will give pressure per square inch allowed. The material used in the construction of flat heads when tensile strength has not been officially determined shall be deemed to have a tensile strength of 45,000 pounds."

Example: What pressure would be allowed on a flat, unstayed circular head 20 inches diameter, ½ inch thick, tensile strength of steel plate, 55,000 pounds?

Then

$$P = \frac{1/6\ 55{,}000\ (\tfrac{1}{2})}{314 \times .09} = 163 \text{ lbs.}$$

"Pressure Allowable for Concaved Heads of Boilers.—Multiply the pressure per square inch allowable for bumped heads attached to boilers or drums convexly by the constant .6, and the product will give the pressure per square inch allowable in concaved heads."

According to Prof. Gashof the strength of flat plates is:

Let t = the thickness in inches.
r = radius of circular support.
p = uniform load in pounds per square inch,
f = greatest stress per square inch.

For plates supported, but not fixed on a circular support, Fig. 2, the maximum stress is:

$$f = \frac{5r^2}{6t^2}P. \quad t = r\sqrt{\frac{5P}{6f}} = 0.91r\sqrt{\frac{P}{f}}.$$

Example: Required, the safe distributed pressure per square inch for a steel plate ¾ inch thick supported but not fixed on a circular support 20 inches diameter, ultimate tensile strength of plate, 55,000 pounds, assuming a factor of safety of 5.5, stress not to exceed 10,000 pounds per square inch, the working pressure will be:

$$P = 10{,}000\,\frac{6}{5} \times \frac{.75^2}{10^2} = 46 \text{ pounds.}$$

For a circular plate fixed at the edges and uniformly loaded (Fig. 3) the maximum stress is:

$$f = \frac{2}{3}\,\frac{r^2}{t^2}\,P. \qquad t = r\sqrt{\frac{2P}{3f}} = 0.81\,r\sqrt{\frac{P}{f}}.$$

For the strength of flat stayed surfaces Prof. Unwin finds for Fig. 4,

$$f = \frac{2}{9}\,\frac{a^2}{t^2}\,P. = .222\,\frac{a^2}{t^2}\,P.$$

When a = distance of stays center to center.

These rules are only suitable for thin flat plates strained within the elastic limit. When the plate is arched or dished, so as to form a concave or convex surface, the strength is greatly increased. Suppose t = .3125, a = 4 inches and P = 175 pounds, then $\frac{2}{9}\,\frac{4^2}{.3125^2} \times 175 \doteq 6405$ pounds, greatest stress per square inch.

Details of different forms of braces and attachments for staying flat surfaces, are shown in Figs. 5 to 14. Where two or more braces on any one line can be used, a heavy steel T forms the best and most convenient attachment and is used in connection with braces terminating in a jaw shown in Fig. 5. Suitable ends to fasten to the boiler shell are shown in Figs. 11 and 14. Fig. 12 shows an attachment where two angle irons, back to back are used, the brace being in the center. Two styles of throat braces are shown in Figs. 6 and 7, the former being attached to the plate with two rivets and provided with thimbles to allow free circulation of water between the plate and the brace; the latter is a round brace with enlarged end riveted hot into a deeply countersunk hole, which should be at least ⅛ inch larger in diameter than the body of the brace.

Convenient forms of "crow feet" are shown in Figs. 8 and 9.

These are used for the attachment of single braces in places where tees cannot be used. Another and larger form using three rivets is shown in Fig. 10. Where long straight braces are used with nuts at each end, Fig. 13 shows the usual form of application with copper washers on the outside. The outer nut is turned cylindrical a sufficient distance to admit of using a calking tool to upset the copper washers in case it is not perfectly steam-tight when screwed up. A cap nut is sometimes used on the outside to prevent leaking around the threads, and to do away with riveting over the ends of the braces in the nuts.

CORRESPONDENCE.

BOX CAR ROOFS.

Editor American Engineer and R. R. Journal:

Noticing your article on "Box Car Roofs" in your November number, page 356, I am constrained to take issue with some of your statements, because I believe the facts developed in service do not warrant them.

It is, as you say, impracticable to build cars that will not be subject to twist and vibration under severe stresses. It is also true that "the nature of the roof framing is generally not such as to offer much resistance to bending and twisting." This is notably true of most of the modern cars. You suggest greater strength by diagonal rods in the roof or double boarding, thus admitting the desirability of increasing the rigidity of the car through the roof, and then in the next paragraph you say, "The roof certainly is not the place to stiffen the frame." This is rather a startling contradiction. Take a car well braced in sides and ends, as most modern box cars are, and it is then found desirable and necessary to stiffen the frame, where will you do it, if not in the roof? You surely can't do it by contributing "flexibility" instead of rigidity.

Now, as to a "large amount of flexibility" which you say "cars must have, and to which the roof must accommodate itself without leaking." Here, surely, is another remarkable statement. Your assertion followed to its logical conclusion would produce results in the cost of maintenance of rolling stock which would bankrupt all the Vanderbilts in the world. How would a "large amount" of flexibility do, for instance, on the "Lake Shore" or "Pennsylvania Limited," especially if that "large amount" of flexibility extended to the engines?

Now, the truth is the stiffest box car, day coach, sleeping car or engine that can be built has flexibility forced into it, so to speak, by the "service stresses" as indicated in your article, and which enforced flexibility is constantly being fortified against in old and new work.

Again, the first half of your article clearly contradicts the latter half. You quote approvingly a statement made before a Railway Club as to flexibility, and then quote approvingly from the proceedings of the M. C. B. Association as to stiffness. Which horse shall one ride?

No, if any truth relating to car construction and founded on service experience has been clearly demonstrated, it is that a roof must contribute its full share of stiffening to the frame. This fact is borne out by the most approving testimony of the most thoughtful men who have formally expressed themselves in reports of Committees or M. C. B. Associations. They have clearly and unequivocally stated that the four long sides of the box of a car should be boarded in solidly "to stiffen and strengthen it."

Now, flexibility is highly undesirable, because it contributes very largely to the cost of maintenance. Take a car with an outside metal roof, and that affords the flexibility you approve—under load—and its strain producing movements are simply astonishing to anyone who will take the time to watch it from the top of a train. There is not only a swaying, twisting motion, but it is serpentine, as well, the effect of which is manifested in the nails working out of roof boards, as well as sides of the car. Not only that, but the whole structure is loosened in tenons and braces and tie rods and inside ceilings. Now, it must be readily evident that when the top of the box of a car is also boarded over before the roof is put on, the effect of twisting and serpentine movement is reduced to the minimum—the least obtainable on a box car at a usable cost.

Once having the body of the car as rigid as possible, i. e., solidly enclosed on four sides, but subject to enforced flexibility, it then becomes highly desirable to have a flexible roof. Perhaps that is what you really mean in your advocacy of flexibility.

There are flexible and inflexible car roofs. The flexible roof has strain adjustability—is torsion proof—because it is not fastened to the body of the car in such manner as necessarily to adjust itself to strain. Such a roof—fabric or metal—can never be unfavorably affected by torsional strain.

An inflexible car roof is one nailed at all points to the structure of the car and hence must be subject to all strains and twists affecting the car. Such roofs soon become leaky, no matter what the material. If of fabric, they tear; if metal, they crystallize, and there is only "vexation of spirit."

There are one or two additional points in your article to which I would like to refer in a deferred communication.

November 18, 1899. B. C. ROOF.

[We do not see that we differ with our correspondent in the essentials of this question.—Editor.]

LOCOMOTIVE INSTRUCTION IN TECHNICAL SCHOOLS.

Editor American Engineer and Railroad Journal:

At present some of the technical schools are revising their courses of instruction in locomotive engineering, while others are preparing to offer such courses for the first time; hence a few words of adverse criticism of past methods, and of suggestion for future improvement, may be productive of good results.

Locomotives operate under more variable and exacting conditions than any other class of engines; and the formulae and data derived from stationary and marine practice have little application to locomotives. As an instance of this may be mentioned the fact that, while in ordinary structures subjected to tension a factor of safety of about five is usually considered sufficient, in the design of such parts as locomotive driving spring hangers, actual practice (deduced from failures) has demonstrated that, partly owing to the greatly increased load due to impact caused by the vertical motion of the driving box and the jolting or uneven movement of the engine, and partly as the result of other causes not clearly understood, it is unsafe to allow the working stress to exceed three-thirty-seconds of the tensile strength of even exceptionally good wrought iron.

For students desiring to fit themselves for the duties of motive power officers and locomotive designers, the ordinary course in mechanical engineering, however admirable it may be, is not of itself a sufficient preparation, but should be followed by a special course of at least one year's duration, devoted exclusively to the study of locomotives. Cars, railway shops and machinery, air-brakes, signals, etc., should be included, and the course should be designed to give a thorough insight into general principles, rather than a knowledge of special methods and the design of details, which information can only be satisfactorily obtained in actual practice, much of it being the carefully guarded private property of railway companies and locomotive building firms.

As an example of the character of problems which a superintendent of motive power or locomotive designer is called upon to solve, and the confidence with which such work is undertaken, the following incident may be mentioned.

In 1895, the Baldwin Locomotive Works suggested to the Japan Railway Company that if a specimen of the coal found on their road and considered unfit for locomotive use—it being impossible to burn it in the fireboxes then in service—were sent to them, they would build engines to burn it and guarantee their successful operation. The sample of coal was sent from Japan; forty-four locomotives were shipped in one lot to a distant foreign country, where, in the event of litigation, the builders would have no redress, and guaranteed to burn a fuel hitherto considered worthless. The locomotives gave perfect satisfaction, proving to be remarkably free steamers, even with exhaust nozzles so large that the engines are almost noiseless in their operation.

Now, how was this satisfactory result attained? Briefly, by adopting a special, though well-known, type of firebox—

the modified Wootten—and so proportioning the grate area that a sufficient quantity of coal (whose peculiarities and calorific value had been ascertained) could be burned per hour to generate steam enough for the tractive power desired, or the traction due to the boiler pressure, and the size of the cylinder and driving wheels. This being accomplished, the design of the different parts or organs of the locomotive, so that they would function properly, not break down or require frequent repairs, did not differ from ordinary cases and presented no unusual difficulties. The broad fundamental problem being the design of an engine which would make sufficient steam to haul trains of known weight over a given road with fuel considered unfit for use.

Another and very different case was recently worked out on one of the well-known American roads. The Lake Shore & Michigan Southern Railway has passenger locomotives which will handle maximum loads of about twelve cars on schedules slightly exceeding forty miles per hour. The traffic conditions have lately become such that the Superintendent of Motive Power was called upon to design locomotives which, without exceeding the limitations of weight and space imposed by the permanent way and clearances of the road, would haul fourteen cars at sixty miles per hour, with a margin of reserve power for emergencies; to meet which requirements a single expansion, 10-wheel express engine was produced, having 80-inch drivers, 20 x 28 inch cylinders, and a total heating surface of 2,917 square feet, equal to that of the largest consolidation freight locomotive (Class H-6) of the Pennsylvania Railroad. Here, as in all cases of locomotive design, the questions were, first, What is wanted? and second, How can it be obtained?

A satisfactory course of instruction in locomotive engineering should be such as to place its graduates, after proper practical experience, in the most favorable position for satisfactorily answering such questions, to accomplish which purpose special prominence should be given to the elucidation of the fundamental principles underlying the design of efficient locomotives; to the explanation of the requirements of modern engines, and how they are met under existing limitations: the tendencies of recent practice, and the probable characteristics of the locomotive of the future.

These are the most important subjects for the technical schools to teach, for, unless so taught, they can only be acquired by years of practical experience and observation, and it is precisely in neglecting to give proper instruction in these underlying principles, and by making the design of details the essential feature, that many of the college courses in locomotive engineering have hitherto been radically defective.

On the other hand, while the consideration of the design of details should not be given undue prominence, it must be remembered that the managements of the leading railroad companies now accept no excuse for engine failures, and consequently the study of successful practice as exemplified in designs which do not break is extremely important, and this involves questions of the resistance of materials under specially difficult and frequently misunderstood conditions.

One of the most admirable features of medical education is the systematic instruction given by eminent physicians and surgeons in regular practice, and, while it is probably impracticable to follow a similar course in engineering education, it is evident that, unless the technical schools are willing to offer such salaries as will induce able motive power officers and locomotive designers to vacate their positions and become teachers, the best results, for the students, at least, cannot be obtained; the tendency being for the course to become either an extravagant exercise in applied mathematics, or to degenerate into a mere catalogue of obsolete locomotive details.

EDWARD L. COSTER,

New York, Nov. 20, 1899. Assoc. M. Am. Soc. M. E.

[Comments upon this subject will be found on page 391, this issue.—Editor.]

A tie growing experiment is reported to be under consideration by the "Big Four," between Brightwood and Ingalls, in Indiana, on land owned by the road. It is estimated that catalpa trees, imported from Kansas, planted now, will attain a height of 60 feet and a diameter of 20 inches in about 16 years.

RAIL WASHER TESTS.

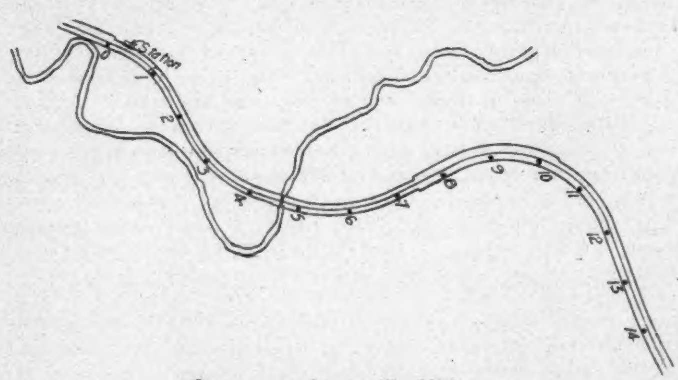
Chicago, Burlington & Quincy R. R.

Train Resistance Due to Rail Sanding.

Dynamometer Tests.

The effect of sand placed upon the rail to increase the adhesion of locomotive driving wheels has been known to be important in increasing the resistance of trains and the subject has, we believe, been submitted to a careful test for the first time by the C., B. & Q. Railroad, and the American Engineer and Railroad Journal has been favored with the results of careful dynamometer experiments conducted by the motive power department of the road under the direct supervision of Mr. J. A. Carney, Master Mechanic of the St. Louis Division, and Mr. M. H. Wickhorst, Engineer of Tests.

This work resulted from discussions with train and engine men with regard to the use of the rail washer, the men claiming that it would make a decided difference in the ease with which heavy trains may be pulled over grades, and especially those involving curvature. Preliminary experiments were made in the Galesburg yard to determine the effect of the rail washer, and it was found that its advantage was so slight upon a heavily sanded rail and a straight, approximately level track that it did not at that time appear to warrant the introduction of the device on main line engines. The claim was

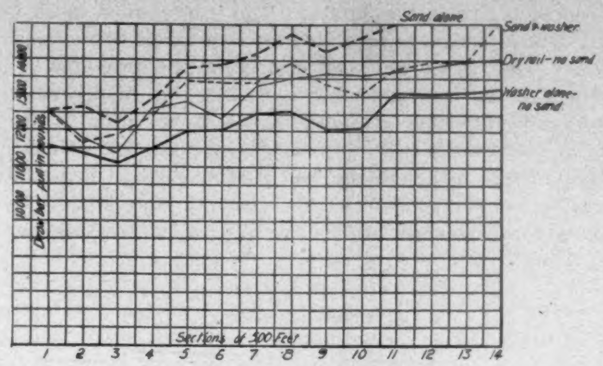


Curves on Arenzville Hill.

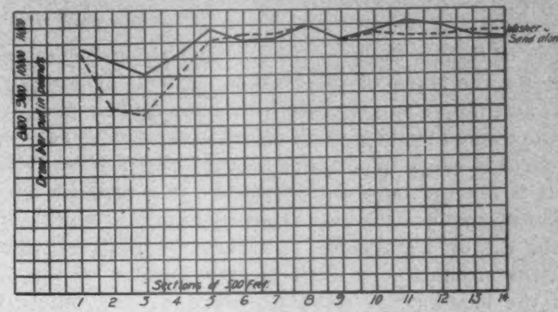
made by men on the St. Louis Division that by wetting the rail lubrication is provided to a certain extent, reducing the flange friction on curves. The almost unanimous opinion resulted in dynamometer tests to settle the question.

The object of the tests was to determine the difference in train resistance when sand was left on the rails after the passage of the engine, and where the sand was washed off behind the drivers with a rail washer, which consists of a pipe tapped into the boiler below the water level, with a branch extending to each rail so that the sand may be washed off by a stream of hot water and steam under the control of suitable valves. The dynamometer car, which is a part of the equipment of this road, was used and the trials were made on October 31 on Arenzville Hill, on the St. Louis Division, where the desired track conditions were found. The hill was staked out in 14 sections, each 500 feet long. One of the engravings is reproduced from a map showing the line of road and the curves on this hill. The grade throughout the space covered is 1.3 per cent. and uniform; the location of the stakes is shown in the engraving.

The weather was fine, and there was very little wind. The full train consisted of 12 loaded cars, with a dynamometer and caboose; other tests were made with three-fourths of a full train, consisting of nine loaded cars, the dynamometer and caboose. The following record shows the order of the tests and indicates that in three cases, with a full train of 3,967 tons, and where sand was used without the washer, the train



Full Train Record.



Light Train Record.

stalled before reaching the top of the hill, at sections 10, 11 and 12. In all the other cases the train was pulled up over the course without stopping.

Record of Tests.

Test No.	Time.	Condition of Rail.	Train.	Remarks.
1	7:55 A. M.	Sand alone.	Full train, 3,967 tons.	Preliminary test.
2	8:33 A. M.	" "	" "	Stalled on Section 10.
3	8:46 A. M.	Sand and washer	" "	
4	9:16 A. M.	Sand alone	" "	Stalled on Section 12.
5	9:30 A. M.	Sand and washer.	" "	
6	11:15 A. M.	Sand alone.	" "	Stalled on Section 11.
7	11:38 A. M.	Sand and washer.	" "	
8	11:52 A. M.	Dry rail—no sand.	" "	
9	12:06 P. M.	" "	" "	
10	2:15 P. M.	Washer alone—no sand	" "	
11	2:30 P. M.	" " " "	" "	
12	2:49 P. M.	" " " "	¾ train, 3,028 tons.	
13	3:40 P. M.	Sand alone.	" "	
14	3:52 P. M.	Washer alone—no sand	" "	
15	4:03 P. M.	Sand alone.	" "	

The complete report includes the average drawbar pull for each section of 500 feet for each individual test, together with the number of seconds required to pass over each section. It also shows the average drawbar pull for the 14 sections when the engine succeeded in getting up the hill. It gives the average drawbar pull for the tests over the first nine sections with a full train. The summary of the results is given in the following table:

Summary of Results.

Summary—Full Train.

Condition of Rail.	No. of Section.	Av. D.-B. Pull.	Rating.	Rating.
Sand alone	9	13,436	100 %	107.5%
Sand and washer	9	12,868	95.7%	102.9%
Dry rail	9	12,511	94.8%	100 %
Washer alone	9	11,830	88 %	94.7%

Summary—Three-Fourths Train.

Sand alone	14	10,585	100 %
Washer alone	14	10,275	97 %

It will be noticed from this summary as to the full train tests, taking the dry rail as normal and rating it at 100 per cent., that when sand was left on the track the resistance was increased by 7.5 per cent.; when sand was applied and then washed off with a washer the increase of resistance was 2.9 per cent, and when the sand was not applied, but the rail was wet by the washer the resistance was decreased to 94.7 per cent. In the tests with the three-quarters load the difference is decidedly less. In this case, calling the resistance where sand was applied 100 per cent., the resistance where no sand was applied but the rail wet with the washer decreased to 97 per cent., a difference of only 3 per cent. in this case.

These results are shown graphically for ease of comparison, the averages having been plotted in the two diagrams which we reproduce. No tests were made with application of sand and afterward the washer to wash off the sand in the case of the lighter train, because it was assumed that the results would be the same as in the application of the washer to the dry rail. The diagram of the full train shows that the resistance is materially greater when sand is applied and then washed off than when the washer alone is applied. It should be stated that the drawbar pulls are reported as they were taken in the tests without correcting for the differences in internal train friction resistance due to differences in speed and for differences in train inertia resistance due to differences in the speed retardation, because the amounts of correction would not be very different in the different cases. If these corrections were applied the draw-bar pulls would be increased slightly, and a little more when sand alone was applied in the case of the full train tests, since the speed retardation was greater in these cases. In the case of the light trains no corrections were necessary, since the variations in speed were very slight for the different tests and for the different sections in each test. If these excellent results were obtained at an excessive cost, due to the amount of water used by the rail washer, the practical value of the device would be very small, but tests conducted by Mr. Carney showed that the amount of water consumed with the throttle valve to the washer pipes fully open was 36 pounds of water per minute as a maximum. His opinion is that the average amount of water used per minute is about 20 pounds, which would be equivalent to a little over 1 pound of coal per minute. If the rail washer is applied for 6 minutes in getting up the hill it would mean the consumption of about 7 pounds of coal and 140 pounds of water, which is very little cost when considered from the standpoint of the advantage in the possibility of hauling additional loads and insuring against the stalling of trains.

Summing up, it may be stated that these tests show a material reduction in train resistance due to washing the sand off the track under the conditions of grade combined with difficult curvature, such as exist on this hill. In a train of 20 loaded cars this is equivalent to the hauling of one extra car. The results also indicate that where the rail is good and no sand is needed, that it is an advantage to apply the washer alone. When a train passes a curve, one wheel of each pair must slip; that is, half the wheels in the train must slip upon the rails. This probably accounts for the good effect of having the sand washed off the rail, and of wetting the rail.

In such work as this a railroad may secure information by the use of a dynamometer car, which will render such an addition to its equipment a most satisfactory investment. The whole idea of the tests and the practical value of the results obtained on this occasion and in many other similar investigations on this road should bring the dynamometer car before progressive railroad men as a very important factor in reducing operating expenses. In this series of tests, which were concluded in a single day, information was obtained which will mean one more car per train over the St. Louis Division for future years. This result alone will pay, over and over again, the total expense of this car ever since the Burlington Brake Tests and including its first cost and replacements. The wonder is that every strong road does not see the real value of the dynamometer car and of the kind of men who can use it to such effect.

A type of compound locomotive in use on the Chemins de Fer du Nord, of France, described in "The Engineer," has high-pressure cylinders 13⅜ inches, and low-pressure cylinders 20⅞ inches in diameter by 25 3/16 inches stroke. The initial steam pressure is 213.3 pounds per square inch, the diameter of driving wheels is 84 inches, the grate area is 24¾ square feet, and the heating surface 1,890 square feet.

STAYBOLT PROGRESS.

The test of time is the most reliable and altogether satisfactory one for the study of the staybolt problem in locomotive practice, and the vibration tests which now attract the attention of the leaders in the pursuit of this subject have developed several facts of great importance because they are really time tests. It is not the tensile strength but that property of the metal which enables it to bear repeated bendings which determines the life of a staybolt. If a perfectly flexible material of sufficient strength was available the solution of the difficulty of the breakage of staybolts would be had, but in the absence of such material it is necessary to use the best to be found and then to surround it with the most favorable conditions. Progress has been made toward improvement since the summary of staybolt practice was printed in our issue of September 8, 1897, page 319, but it is believed that the increase of steam pressures is moving faster than that of the improvement in staybolts. This is why it is important to review the subject.

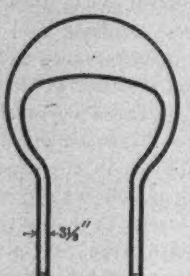


Fig. 1.

Fig. 2.

Fig. 3.

Remarkable Staybolt Material.

The recent cutting up of an old locomotive boiler after it had been in active service for nearly 20 years presented some interesting questions. This boiler was equipped with staybolts ⅞ inch in diameter, which were turned down to a diameter of ⅝ inch in the center, with a long fillet at each end. The original firebox sheets and a large part of the original staybolts were still in use, although of course a number had been renewed. The points of interest in this case are: First, That so many of the staybolts should have lasted for nearly 20 years; second, that the firebox should have lasted so long a time and yet be fit for further service, and, third, that some of the staybolts should have broken near the firebox side, instead of near the outside shell. A case of a staybolt breaking at or near the firebox side is almost unheard of and it would seem that if the form and method of attachment are found which will cause the bolts to break at either sheet all has been done that is possible with that size of staybolt. Examination of this staybolt iron by etching and by tests showed it to be remarkable material. Its tensile strength was from 55,000 to 58,000 pounds, and the elongation was 40 per cent. in 2 inches. This was not steel, as might be supposed from the high tensile strength. It was box piled, faggotted iron made up, as shown by the etching, of very small squares covered by a box on the outside. The iron seemed to be very highly refined before being rolled into the small bars of square section. This is shown very clearly in the fractures. The structure of the iron appeared to be like that of a rope with square and untwisted strands. Little if any iron is to be found at the present time with tensile strength and elongation as high as this, although the best special staybolt irons often run up to 53,000 pounds tensile strength and 30 per cent. elongation in 8 inches. Of course the boiler pressure has a great deal to do with the life of staybolts. In this particular boiler it was 125 pounds during the more recent years and possibly 140 pounds during its earlier days.

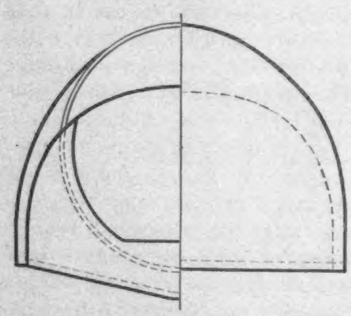


Fig. 4.

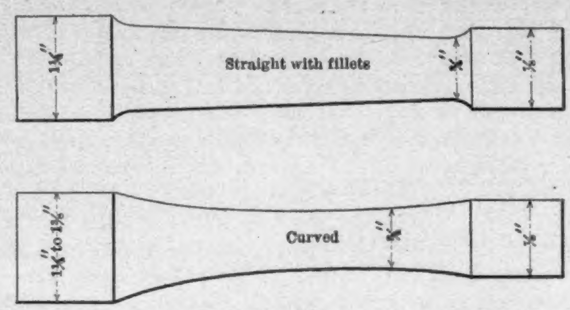


Fig. 5.

Form of the Firebox.

If staybolts could be made of sufficient length to permit of the maximum movements of the firebox due to expansion and contraction without bending them beyond the elastic limit of the material and without reaching the point of permanent set the dangers of breakage would be greatly reduced. It is out of the question to materially increase the length of the bolts which give the most trouble in narrow fireboxes, but with wide fireboxes there seems to be no reason why moderately long bolts may not be used without any important disadvantage. With fireboxes of the narrow type (between the driving wheels) the shape may be much more favorable than is often the case. On page 179 of the June, 1899, issue of this journal a boiler is illustrated in which the water spaces, while 4 inches wide at the bottom, increase both at the sides and back end in order to give as great length as possible.

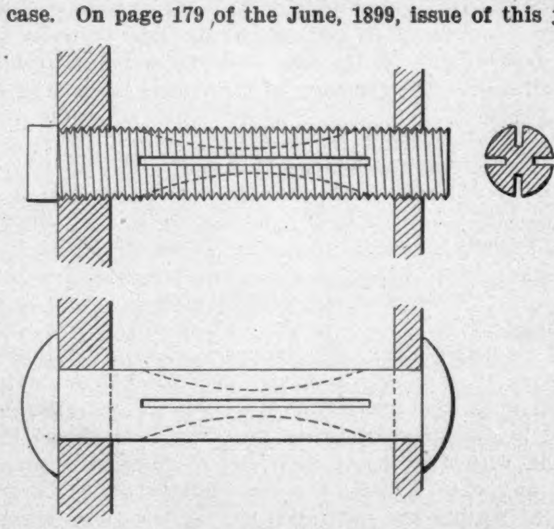


Fig. 6.

The shape of the firebox sides may be varied quite a little with a marked effect on the staybolt breakages and probably much more influence than is generally appreciated. Of the three forms of fireboxes shown in Figs. 1, 2 and 3, the first represents 10, the second 18 and the third 24 locomotives, which were compared for staybolt breakages during a period of six months and gave the following results:

Fig. 1.—226 broken.
Fig. 2.—124 broken.
Fig. 3.—32 broken.

Standard Forms of Staybolts.
C., B. & Q. R. R.

Diameter.		Radius of Curves in Inches	Length Between Sheets.																
Nominal.	Actual at Center.		3 in.	3¼ in	3½ in.	3¾ in.	4 in.	4¼ in.	4½ in.	4¾ in.	5 in.	5¼ in.	5½ in.	5¾ in.	6 in.	6¼ in.	6½ in.	6¾ in.	7 in.
⅞ in.	11/16 in.		42	42	42	42	42	80	80	80	80	80	80	140	140	140	140	140	140
15/16 in.	11/16 in.		23	23	23	23	23	42	42	42	42	42	80	80	80	80	80	80	80
1 in.	11/16 in.		23	23	23	23	23	42	42	42	42	42	80	80	80	80	80	80	80
1 1/16 in.	23/32 in.		23	23	23	23	23	42	42	42	42	42	80	80	80	80	80	80	80
1⅛ in.	¾ in.		23	23	23	23	23	42	42	42	42	42	80	80	80	80	80	80	80
1 3/16 in.	25/32 in.		23	23	23	23	23	42	42	42	42	42	80	80	80	80	80	80	80

The first is a radial stay boiler with a deep firebox and 3½-inch water spaces, carrying 180 pounds of steam; the second is a crown bar boiler with 3¼-inch spaces, carrying 150 pounds, and the third is a radial stay boiler with a rather deep firebox but 4½-inch water spaces and less abrupt curves at the sides. This is an easy matter to provide for in designing, and the reason for the good results is very clear.

A shallow firebox is much more favorable to staybolts than a deep one, and with wide grates, over the wheels, the best possible arrangement for the staybolts seems to be available, viz., a shallow box, an even and uniform curvature of the sheets and long staybolts. The curvature of the sheets is believed to be important. It has been found advisable in the construction of very wide fireboxes to give the sheets a uniform curvature from one side to the other, not that the section of the firebox is an arc of a circle, but the outline is free from angles and straight lines which tend to localize the movements and stresses due to expansion and contraction. In 10

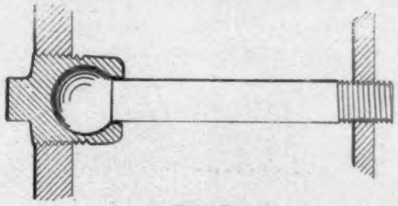


Fig. 7.

engines with fireboxes of the form shown in Fig. 4, but 3 broken staybolts were found in a period of 13 months. This is believed to be due to the shape of the sheets, and the length of the staybolts which begins to increase immediately above the lower rows, and the stays are very nearly radial throughout the firebox. The record is a very encouraging one, which appears to add an argument to those in favor of wider fireboxes. Fig. 4 may fairly be said to represent the forms of the Lehigh Valley Baldwin Compounds (page 11, January, 1899), the Long Island and Consolidations by the Brooks Works (page 92, March, 1899), and the most recent Brooks 12-wheel engines for the D., L. & W. Ry. (page 365, November, 1899). These engines are all reported to be giving good results and this shape seems to be likely to last.

Forms of Staybolts.

For a number of years the practice of reducing the size of the central portions of the bolts between the threaded ends has been rather common. Two recent investigators believe that the idea is theoretically good, but that it does not show marked results in vibration tests. The long service of the staybolts referred to in the first part of this discussion seems to prove the value of the flexibility obtained in this way. Efforts have been made to design such a form as would insure against the breakage occurring always at the outer sheet. Fig. 5 shows the results reached by two prominent locomotive authorities who worked out their ideas independently and both sought the theoretically correct form. They differ in nothing except the form of the section between the fillets. The difficulty with this plan is to make and insert the bolts. This can be done, but at increased expense, because of the two sizes of holes to be drilled and tapped for each staybolt. The form shown in Fig. 6 was designed by Messrs. Stone & Co., Deptford, England, for the purpose of giving flexibility. The staybolt is apparently cut in two planes by a circular saw with a thin blade. Mr. William F. Pettigrew in his new book says: "It is represented that these stays will stand 30 times as many strains as the ordinary stay, and where they have been tried they have given very good results." The experience with this form has probably been confined to England, but experimenting with them on a large firebox in this country would be worth while. They are used in steel fireboxes on the Great Eastern Ry. of England.

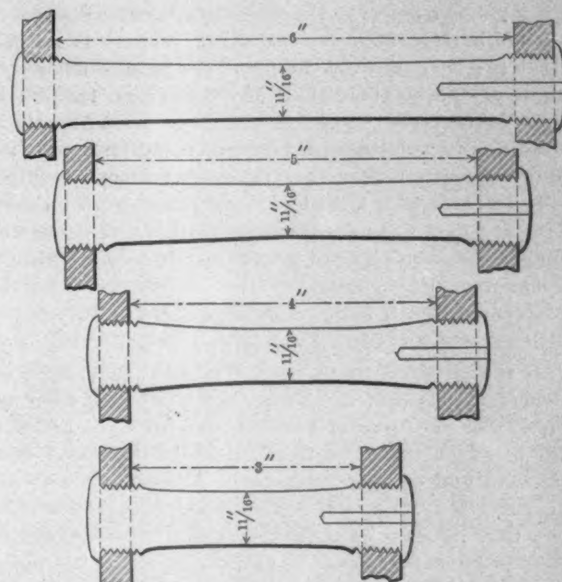


Fig. 8.

A really flexible staybolt is sure to be durable. The form shown in Fig. 7 has been suggested as a means for providing flexibility at the outer sheet, but it is not known to have been tried in service. Doubtless this idea may be worked out successfully, and perhaps without making the work too expensive. This is believed to have originated with Mr. F. W. Johnstone, Superintendent of Motive Power of the Mexican Central.

Fig. 8 illustrates the form of the standard staybolts of the C., B. & Q. R. R., which gave excellent results in a recent series of vibration tests. These bolts with drilled holes withstood more vibrations than any others, except nickel steel, in a comparative test of six different forms and materials. On new work, on the Burlington, ⅞-inch bolts are used, the lengths varying by ¼ inch, and the shape being as given in the table. In renewing staybolts, sizes up to 1 3/16 inches are used as the work requires, and if larger ones are needed the holes are bushed and standard sizes are put in. The minimum diameter of ⅞, 5/16, and 1-inch staybolts is 11/16 inch, and for bolts over 1 inch diameter the minimum diameter increases 1/32 inch for each 1/16 inch increase in the nominal diameter.

The Riveting of Staybolts.

The form and size of the riveted head of the staybolt is known to greatly influence the life, and that the riveting is very important is proven by the wide variations in the results of tests in vibration machines with bolts secured in this way. At least three different experimenters have tried unsuccess-

fully to carry out tests in which the bolts were riveted into sheets, but the results were so variable as to be valueless. The heads loosened first, and the bolts finally broke near the edge of the plate. It has been stated that bolts driven according to the method suggested by the United States Government gave materially improved results. The amount left to be headed over on a one-inch bolt was 7/16 inch; after upsetting the end by a few sharp blows the bolt was driven by a bottom set and when driven by this method it withstood more bendings than those with low conical heads and also bolts remained tight longer. The explanation is that this method of driving made the bolt stiffer at the sheet and threw a part of the flexure into the portion between the sheets. An experimenter whose opinion is held in high esteem, says: "There is no question but that the heading over the plate has more influence on the strength of the staybolt than any other one factor. It has been found that the United States Government specifications for heading staybolts gave a much more uniform test, as well as showing much longer life. The Government requires the heads to be made with a set and use no hand work on them."

There are two ways in which to look at this question of driving. Loose bolts do not break, and it seems highly probable that very tight bolts with provisions for bending will have increased life; it is better to have them tight.

Detector Holes in Staybolts.

When the detector holes were first used they were drilled after the completion of the boiler and many still keep up this practice. For the sake of economy it afterward became customary to punch the holes in the bolts in the shop. Methods of punching and etching prints of punched bolts were shown in the American Engineer, April, 1898, page 121. It has developed that in spite of opinions to the contrary, drilling is better than punching and in a number of shops the holes are now drilled before the bolts are threaded. It has been shown by vibration tests that the holes, whether punched or drilled, increase the life of the bolts, but that drilling is the more effective. The punching seems to cause the breakage to occur in a ragged, irregular way, which would indicate that the deformation of the material was not advantageous. In one series of tests the number of vibrations with the holes drilled was nearly 2½ times as great as in the case of the same form with punched holes.

Thin Sheets.

There is a tendency toward the use of thinner firebox sheets in spite of the increase of boiler pressures, the purpose being to reduce the rigidity of the firebox structure and to relieve the staybolts by inducing some flexure in the sheets themselves. Examples are seen in the new Lake Shore passenger engines with inside firebox sheets ⅜ inch thick; the large 12-wheel freight locomotive for the Illinois Central with inside sheets 7/16 inch thick and the Class H 6 consolidation engines of the Pennsylvania, in which the inside sheets are only 5/16 inch, and the outside sheets but ⅜ inch thick.

The Pennsylvania practice is believed to be a satisfactory indication that much thinner sheets are to be used than were formerly considered necessary. Outside firebox sheets less than ½ inch thick appear radical, but because of the support given by the staybolts more than this is probably not necessary. It is reasonable to expect the stays to be more reliable in supporting the sheets if the latter are thin and flexible.

Staybolt Material.

The influence of the quality of the material is important, as was shown by Mr. F. J. Cole before the American Society of Mechanical Engineers last year. The material should not only be good, but should be uniformly able to withstand the stresses and the test of quality is in the vibration machine. As already mentioned, some of the irons available about 20 years ago are worthy of attention in this respect and more will be said in this connection. The very best iron should be obtained regardless of cost.

Nickel steel seems to be able to withstand alternating stresses very well, and better than any other material, yet it appears to be barred out from practical consideration because of the difficulties of working. It is necessary to thread the bolts in a lathe or to anneal them before cutting the threads in a bolt machine. Good iron is undoubtedly the best material.

Piling Structure of Staybolt Iron.

The most intelligently prepared specification for locomotive staybolt material in this country contains the following

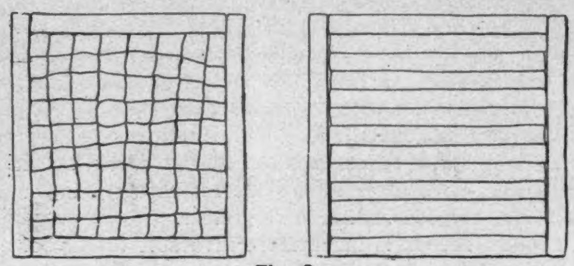


Fig. 9.

clause: "The material desired is fagotted iron, free from admixture of steel and preferably box-piled, the filling being of rods."

Fig. 9 indicates two methods of piling iron for staybolts; the first is intended to represent what is referred to as "box piling," and the other is slab piling. It is clear that in the first the structure is such as to enable one portion to support the others in whatever direction the bending occurs, whereas in the second there is a marked difference in the support in the different planes of bending. The numbers of vibrations representing the first and second structures are recorded as

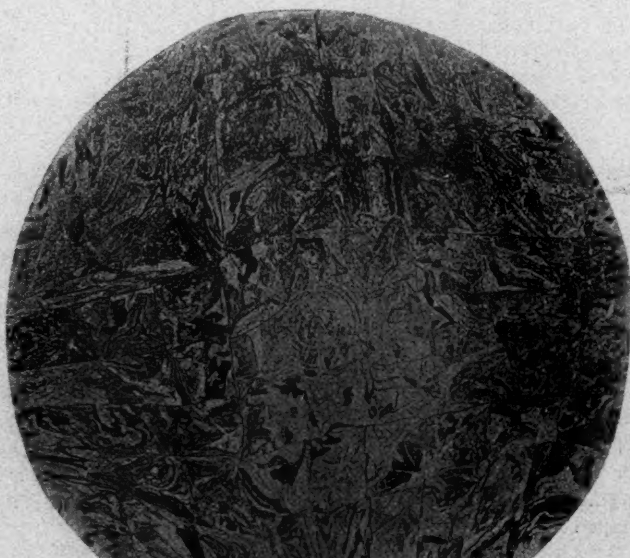


Fig. 10.

from 5 to 1 and 2 to 1 in favor of the first in tests made by two careful experts working independently and on different irons. If the slab piled iron is bent with the piling in the vibration machine it gives good results, but when bent against the piling it is less satisfactory, even if the material is equally good. No satisfactory etching print of a box piled piece showing the rods is available, but Fig. 10 shows the structure, within the box, although this specimen is not a staybolt. It is an axle of a kind not seen nowadays and is made of 81 distinct pieces welded together in working.

Fig. 11 shows etched ends of five different well-known brands of staybolt iron, Nos. 1 and 3 of which exhibit the slab struc-

ture, while the others are more irregular. The irregular piling seems to a certain extent to act like the box piling in furnishing the internal support which is so desirable in resisting repeated bendings. An excellent example of the slab piling is seen in Figure 12. There is good reason to believe that irons represented by Fig. 12 should be tested in a lathe with a weight upon the unsupported end, in order to insure against misleading conditions. (This is a section of an axle.)

An excellent example of carefully worked iron which shows the irregular structure, apparently so desirable, is presented in

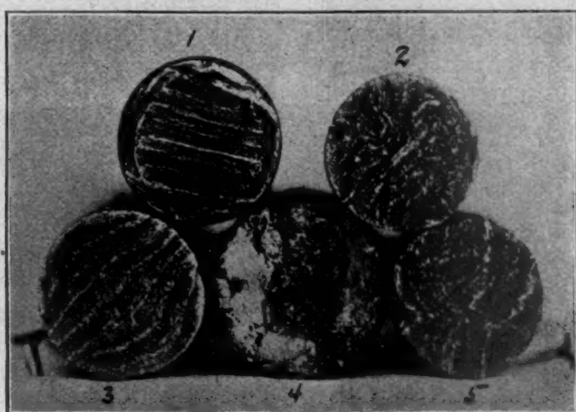


Fig. 11.

Fig. 13. This engraving is from an etching of a piece cut from a bar taken at random from storehouse stock. It is superior iron and the etching in this case confirms its good reputation.

The internal structure of another special staybolt iron is shown in Fig. 14; this, like Fig. 13, is engraved in wood from the original etching prepared from a commercial sample of

Fig. 12.

the material obtained from railroad storehouse stock. Fig. 14 shows a very different structure from Fig. 13. The material has some hard spots, but aside from these its iron is so homogeneous as to render it difficult to secure a good etching for engraving. This iron appears to be piled finally in slabs, each slab being comprised of rods. Its structure differs from Fig. 10 in the way it is made, but it also differs from Fig. 12, and from Sections 1 and 3 of Fig. 11. The structure of Fig. 14 resembles, in general principles, the box piled iron but it is not strictly an example of that structure.

Fitting.

The application of staybolts so as to insure uniform duty on each and freedom from initial stresses is difficult and the subject is sufficiently important for more thorough treatment than can be given here. The accuracy of the threads is now being carefully measured, and this cannot fail to produce improvements. Mr. H. A. Gillis, of the Richmond Locomotive Works, stated before the Master Mechanics' Association last summer that he had ordered staybolt taps in the open market from every known maker of any reputation whatever, and "found only two taps out of the number that were anything like right." This situation is bound to improve when the necessities are appreciated. The ideal to be sought for is a uniform condition of initial stress among the staybolts. This cannot be secured under prevalent practices in which the inside sheet is deflected as much as ⅝ inch by the pressure of the reamer on the end of the staybolt tap which is fed into the hole with a 1/12 inch feed per revolution. This is true of the usual method of reaming the inner hole by a reamer on the end of the tap while the hole in the outer sheet is being tapped by another portion of the same tool, and unless precautions are taken to bolt or clamp the sheets together while the reaming is going on, the inner sheet is sure to be pushed away. The shape of the thread is also important. There is no reason why a staybolt thread should fit the sheet at the bottom. There should be a small space between the top of the thread in the sheet and the bottom of the thread on the bolt. The United States standard thread is better than a sharp V thread for the bolts because the sharpness of the threads at the bot-

Fig. 13.

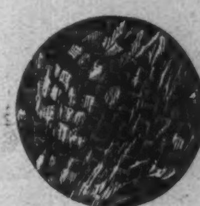


Fig. 14.

tom is equivalent to nicking the bolt and is an invitation to fracture.

Vibration Tests.

These tests seem to have thrown a great deal of light on the staybolt problem, chiefly, no doubt, because they indicate in a large measure what may be expected from long time service tests, and they may be made to very nearly reproduce practical conditions. These tests are now required in the examination of staybolt material in the specifications which are mentioned below and they are considered as giving important information in regard to the material. The effect of the internal structure of the material, however, is such as to raise the question whether these tests should not be made in a revolving instead of a reciprocating machine. The revolving method, with a weight hung on the free end of the specimen, bends the bolt in all directions, whereas in a vibrating machine the motion may happen to be in the most favorable or the most unfavorable directions. It has been very clearly shown that rigid clamping of the fixed end of the specimen (in the vibrating machine) is necessary to uniformity of results and for this reason the riveting of the specimens into pieces of plate for testing purposes has been discarded. Specifications which have been found to secure satisfactory results, include the following: Tensile strength, not less than 48,000 pounds per square inch; elongation, not less than 25 per cent. in 8 inches. Specimens when threaded with sharp "V" threads shall be firmly screwed through two holders ⅝ inch thick and with a clear space of 5 inches between them. One of these holders shall be rigidly secured to the bed of a suitable machine, and the holder at the other end shall be vibrated alter-

nately ⅛ inch on each side of the center line. When thus tested, acceptable iron should show not less than 2,200 double vibrations before breakage. If either of two bars stands less than 1,700 double vibrations or the two give an average of less than 1,900 double vibrations before breakage, the material is rejected.

Conclusions.

The most promising improvements in staybolt practice are: Favorable outlines in the firebox sides, giving smooth curves and allowing the maximum length for the staybolts; such forms of the bolts as will cause the flexure to be distributed over the portion between the sheets; the drilling of tell-tale holes; thin and yielding firebox sheets; the best quality of material; such a structure of the staybolt material as will permit one portion to support its neighboring portions, no matter what the direction of bending; accurate fitting of the threads and accurate pitch of the bolt and tap threads and a correspondence of the pitch in both sheets. It is too early to state positively the effect of the recent experiment on corrugated fireboxes on the New York Central, but success in this direction looks very promising. It may be said that the Vanderbilt boiler on this road has been satisfactory thus far. No serious difficulties have arisen and there seems to be good reason to believe that the experiment will prove it to be possible to do without staybolts altogether in locomotives on American railroads. The fact that five engines now building for this road are to have these fireboxes is interesting.

PISTON VALVES.

With Two Bar Front Frames.

Norfolk & Western Railway.

The Norfolk & Western Ry. has given a great deal of attention to piston valves for locomotives. On page 38 of our issue of February, 1898, an account of an application of valves of this type was given describing their arrangement in a locomotive that was formerly a compound. The latest development is shown in the accompanying engravings, illustrating their use in an engine with two bar front frames combined with a location which places the valves in the direct path of steam in entering and leaving the cylinders. These valves take steam at the center and exhaust it at the ends. The advantages claimed for this are, first, the protection of the entering steam from radiation on account of the jacketing by the exhaust, and, second, the absence of high steam pressure upon the valve stem. In the plan followed in this case the valve motion is connected with the valve in a very direct way without using bent eccentric rods or crooked connections.

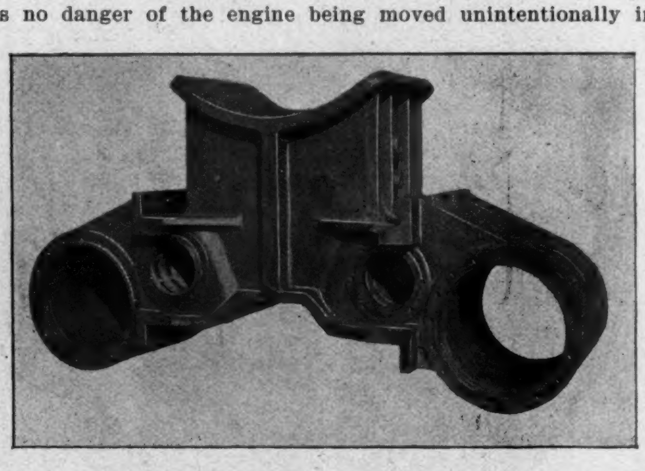
Before adopting this arrangement of the valve motion another, which was much more complicated, was tried. This made use of a system of horizontal levers, connecting the link block with the valve stem, but while giving a good valve motion the use of the plan was not extended because of the large number of joints. The form illustrated has been applied to four locomotives recently rebuilt and is giving good results. The valves are made in two parts in order to get them in between the bent portions of the front frame sections. The valves have three narrow packing wings, like those previously illustrated. These valves are provided with peep holes through the castings to permit of watching their edges while they are being set.

The arrangement of the valve motion is illustrated in plan and elevation. A short substantial bar connects the link to the end of the valve rod. It is hung on two links of equal length, giving a parallel motion which does not introduce any irregularities into the action of the valve. The valve stem is guided at the back end and moves in a straight line, the valve rod being connected to it by a pin joint. A valve motion could hardly be more direct than this unless the valve stem and link block could be placed on a level which would avoid the necessity for the parallel motion. Such a location, however, would not give a favorable arrangement of the steam passages in the saddle casting, even if it could be accomplished.

Piston valves need special protection from water of condensation, from the resistance of the pistons and from the cutting action caused by drawing cinders and dirt from the smokebox while drifting, and for these purposes a novel relief valve has been used, designed, and, we believe, patented by Mr. G. R. Henderson, formerly Mechanical Engineer of this road, and now Assistant Superintendent of Motive Power of the Chicago & Northwestern. This valve is shown in the cylinder drawing. It opens a passage connecting the steam port from the cylinder with the steam passage in the saddle so that when drifting with steam shut off a by-pass from one end of the cylinder to the other is provided to prevent sucking air into

Showing End of Valve Casing Between the Frames.

the cylinder through the exhaust pipe. Unlike the usual relief valve, this opens by gravity and does not require a vacuum to be formed in order to bring it into action. Upon opening the throttle the steam pressure under the valve closes it against its seat and it remains closed unless by reason of the presence of water in the cylinder the pressure above the valve exceeds that of the steam pressure from the boiler. In that case the valve relieves the cylinder. Another advantage of this valve lies in the fact that it opens when the engine stops, and there is no danger of the engine being moved unintentionally in

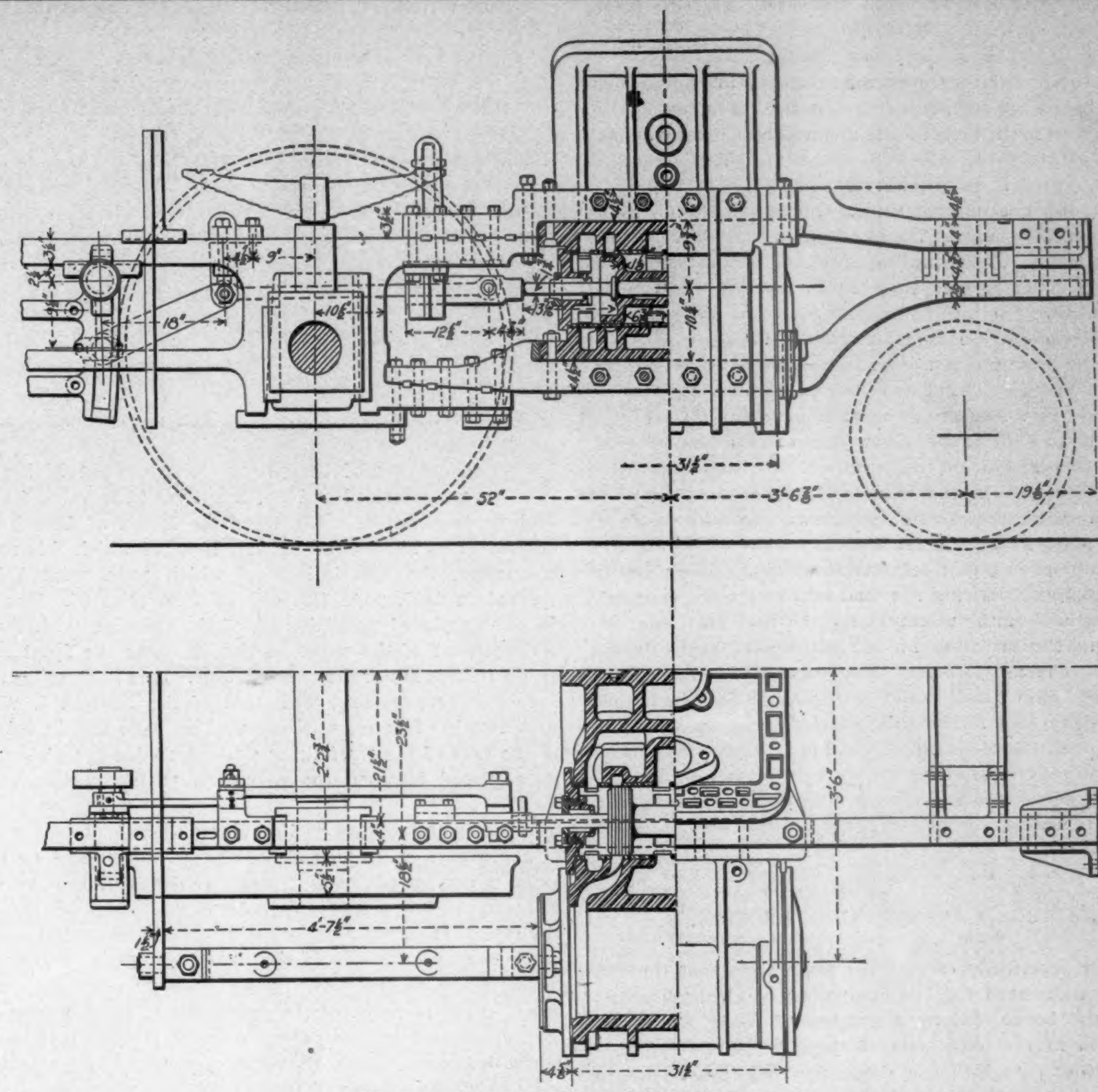


Cylinders and Saddles.

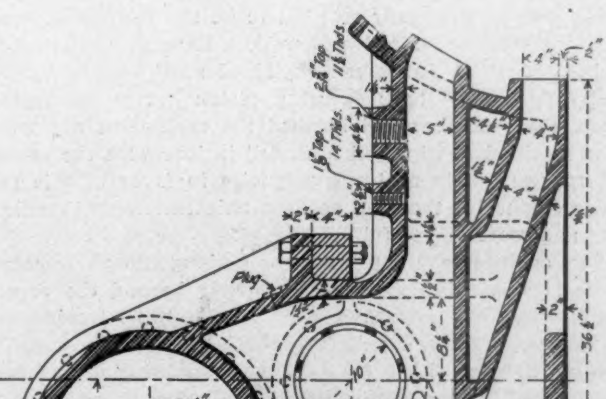
case the throttle leaks. The drawing shows the construction of the valve and seat and the manner of getting at it through the plug hole in the bottom of the cylinder casting. These relief valves are provided for both cylinders.

We are indebted to Mr. W. H. Lewis, Superintendent of Motive Power, for the drawings and photographs.

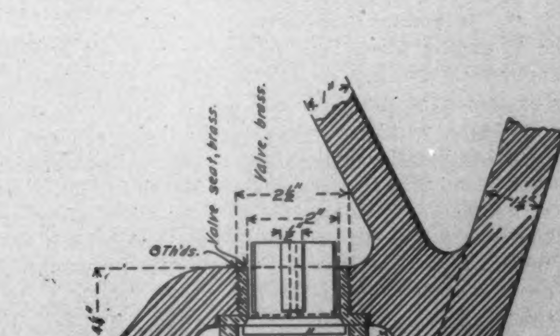
The coal "jimmies," of which the Central Railroad of New Jersey has about 16,000, are long out of date as a business proposition. Mr. Wm. McIntosh, Superintendent of Motive Power of the road, has designed a new coal car of 80,000 pounds capacity, of which 2,500 will be built to give the same coal carrying capacity as was formerly had with the 16,000 small cars.



Sections Showing Valves and Valve Gear.



Section Through Cylinder.



Section Through Relief Valve.

APPLICATION OF PISTON VALVES BETWEEN FRAMES WITH TWO BAR FRONT SECTIONS.

NORFOLK & WESTERN RAILWAY.

INSURANCE FOR EMPLOYEES OF THE ALTON RAILROAD.

Owing to the prohibitory premiums required of railroad employees by insurance companies, the Chicago & Alton has inaugurated a new plan whereby life and accident insurance may be obtained at favorable rates, the idea being clearly stated in the circular, which is as follows:

"The company has entered into a contract with the Aetna Life Insurance Company of Hartford, Conn., the largest company in the United States issuing both life and accident policies, whereby all employees may obtain insurance upon most favorable terms. To aid its employees to secure the best accident insurance at the lowest rates, the company will bear one-half of the premium of the insurance company for all conductors, baggagemen, brakemen, engineers, firemen, bridge carpenters and yard foremen and switchmen; and for all other employees, on account of the lower rates of premium to them, it will bear 30 per cent. of the premium. In connection with this accident insurance the management has also provided for the issuance to those of its employees who may desire it, a term life policy, insuring for a term of not exceeding five years, the employee against death from natural causes; and in aid of the employee desiring the term life policy the company will bear one-half of the premium for the first year, the employee paying the premium for all subsequent years during the term. This term life policy, however, will be issued only to such as hold an accident policy in the Aetna Life Insurance Company, as provided for by this company, and for the same amount. The management offers this opportunity (it is in no respect compulsory), believing the faithful service of its employees, in all departments, warrants it in rendering them substantial aid in the protection of their families and of themselves."

RAILROAD SAFETY APPLIANCES.

It has been practically certain for some time past that an extension of time fixed for the equipment of air brakes and couplers would be desired by a number of roads. The reasons are good in this case, one of them being the impossibility of getting cars into the shops for the time necessary for putting on the attachments, this being due to the unprecedented amount of business on hand. The Interstate Commerce Commission has been very considerate in already extending the time, and the following circular indicates a reasonable attitude toward the present emergency:

Interstate Commerce Commission.

Notice is hereby given that numerous railroad companies have applied to the Interstate Commerce Commission for further extension of time (for the period of a year, or until January 1, 1901), within which to equip their cars and locomotives with automatic couplers and power brakes as provided by Sections 1 and 2 of an act approved March 2, 1893, relating to the equipment of cars and locomotives with safety appliances, and that a hearing upon such applications will be had at the office of the Commission, in the City of Washington, D. C., on Wednesday, December 6th, at 10 o'clock A. M., at which time and place all persons interested will have opportunity to be heard in person or by counsel, whether for or against such extension, and may forward by mail any affidavit, statement or argument bearing upon the question.

By order of the Commission:

EDW. A. MOSELEY,
Secretary.

The annual operating cost of one signal lamp for semaphore or other signals, including oil, care and maintenance, is placed at $12 by Mr. Frank Rhea, of the Signal Department of the Pennsylvania, in a recent paper read before the Railway Signaling Club.

TEN-WHEEL COMPOUND FREIGHT LOCOMOTIVES.

Northern Pacific Railway.

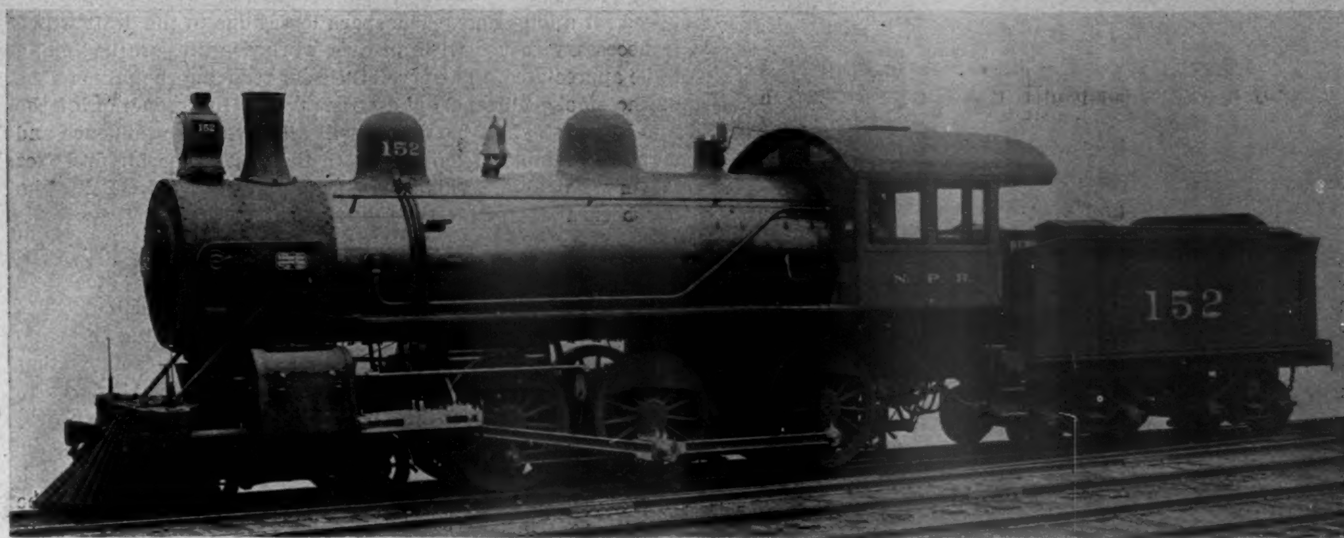
With Piston Valves on High-Pressure Cylinders.

The Schenectady Locomotive Works have completed 14 ten-wheel, two-cylinder compound locomotives for freight service on the Northern Pacific Railway. They are similar in many of their essentials to previous ones on this road by the same builders. The total weight is 175,500 pounds and that on the driving wheels 134,200 pounds; the heating surface is 3,012.7 square feet, and the grate area 34.22 square feet. This is a very large heating surface for the 10-wheel type, and the largest of which we have record. The boiler is the extended wagon-top type, the first ring being 70 inches in diameter. The driving wheels are 63 inches in diameter and the cylinders 22 and 34 by 30 inches.

The advantages of the piston valve on the high-pressure cylinder were desired and the location of the valve was made such as to admit of using the same design of frames as was applied to earlier engines of this type, of which this road has a number, the descriptions of which were printed in this journal in 1897, page 113, and in 1898, page 65. The piston valve was placed upon the top of the cylinder, with the usual arrangement of the valve motion, because the front sections of the frames are of the two-bar type. It is interesting to compare this arrangement with that of the Norfolk & Western, with two-bar frames, as illustrated on page 386 in this issue. In the case of the Norfolk & Western engine the piston valves were placed between the cylinders, without changing the frames, and in addition to the favorable location of the valves in regard to condensation, this places them in the direct course of the steam in its passage to the cylinders, and permits of using a very direct valve motion. Allen-American valves are fitted to the low pressure cylinders.

There is apparently a marked advantage in piston valves on these engines, aside from the theoretical ones, in the ease of handling the reverse lever, which, of course, has an important effect upon the work of the enginemen. These valves render the adjustment of the cut-off so easy relatively to less perfectly balanced valves that the men pay more attention to the use of the lever, and furthermore the decreased strain on the valve gear may be expected to add to this advantage by giving better port openings. In commenting upon piston valves (the form already referred to on the Norfolk & Western), in his paper before the New York Railroad Club, in September, R. P. C. Sanderson explained some unusually good results from road tests favoring piston valves by saying: "From the time they had handled the engine the first eight miles on the first trip, both men fell in love with the engine, and unquestionably a strong prejudice in favor of this particular engine led them to, perhaps unintentionally, handle it more and more successfully."

These engines have not been running long enough to permit of considering this design as completely beyond the experimental stage, but they have given absolutely no trouble, and the results, so far, are very favorable. The packing is in the form of L rings, with a separate bull ring, such as has been used before. In the photograph a small pipe is seen coming from under the boiler jacket and leading to the top of the casing of the extended piston rod. This is to lubricate the extended rod, and oil is fed to the pipe from an independent sight-feed lubricator in the cab. The two small brass plugs in the side of the piston valve casing cover holes through which the edges of the valves and ports may be seen while setting the valves and without taking the heads down. They are also useful in cleaning the cores at this particular part of the casting, but in the shops it is so easy to take the heads down that they are not necessary in the original setting of the valves or in putting them in order when the facilities for doing so are at hand. The piston valve casing has two relief valves, also



Ten-Wheel Compound Freight Locomotive, Northern Pacific Railway.

A. LOVELL, *Superintendent of Motive Power.* SCHENECTADY LOCOMOTIVE WORKS, *Builders.*

shown in the photograph. These afford relief to the piston valve in case water should be forced into the valve, and they perform the relief that is had by the lifting of the ordinary slide valve. This result has been obtained in England by providing relief through segmental packing rings, which will compress and allow the water to pass through into the exhaust, but on the Northern Pacific engines no working parts are added to the valves themselves to rid them of water.

The driving-wheel brakes are applied to the rear sides of the driving wheels, a practice which should become general because of the relief to the spring rigging, through the change of the brake shoe thrusts from a downward to an upward direction. When placed back of the wheels the application of the braker tends to reduce the load on the springs when the engine is moving ahead. The springs are underhung, after the method employed by these builders. The firebox is above the frames and is depressed at the front end to give as great a depth as possible under the tubes.

The important dimensions and particulars of the engines are given in the following table:

General Dimensions.

Gauge	4 ft. 8½ in.
Fuel	Bituminous Coal.
Weight in working order	175,500 lbs.
Weight on drivers	134,200 lbs.
Wheel base, driving	14 ft. 10 in
Wheel base, rigid	14 ft. 10 in.
Wheel base, total	26 ft. 8 in.

Cylinders.

Diameter of cylinders	22 and 34 in.
Stroke of piston	30 in.
Horizontal thickness of piston	5¾ and 4⅛ in.
Diameter of piston rod	3¾ in.
Kind of piston rod packing	Ring 1 in. deep L. P.
Size of steam ports	23 in. by 2⅛ in.
Size of exhaust ports	23 in. by 6 in.
Size of bridges	1⅜ in.

Valves.

Kind of slide valves	H. P. piston valve, L. P. Allen-American.
Greatest travel of slide valves	6½ in.
Outside lap of slide valves	H. P. 1¼ in.
Inside lap of slide valves	Clearance ¼ in.

Wheels, Etc.

Diameter of driving wheels outside of tire	63 in.
Material of driving wheel centers	Cast steel.
Tire held by	Shrinkage.
Driving box material	Cast steel.
Diameter and length of driving journals	9 in. diam. by 11 in.
Diameter and length of main crank pin journals,	(Main side, 7 in. by 5¼ in.)—6½ in. diam. by 6 in.
Diameter and length of side rod crank pin journals,	F. & B. 5½ in. diam. by 4½ in.
Engine truck, kind	4-wheel swing bolster.
Engine truck, journals	6 in. diam. by 11 in.
Diameter of engine truck wheels	30 in.
Kind of engine truck wheels	Steel tired.

Boiler.

Style	Extended wagon top.
Outside diameter of first ring	70 in.
Working pressure	200 lbs.
Material of barrel and outside of firebox	Steel.
Thickness of plates in barrel and outside of firebox	5/16, ⅜ and ½ in.
Firebox, length	120 3/16 in.
Firebox, width	41 in.
Firebox, depth	F. 84 B. 71½ in.
Firebox, plates, thickness,	Sides, 5/16 in.; back, 5/16 in.; crown, ⅜ in.; tube sheet, ½ in.
Firebox, water space,	Front, 4½ in.; sides, 3½ to 4 in.; back 3½ to 4½ in.
Firebox, crown staying	Radial, 1⅛ in. diam.
Firebox, staybolts	1 in diam.
Tubes, number of	376
Tubes, diameter	2 in.
Tubes, length over tube sheets	14 ft. 2 in.
Fire brick, supported on	Water tubes, 3 in.
Heating surface, tubes	2,772.6 sq. ft.
Heating surface, water tubes	32.1 sq. ft.
Heating surface, firebox	208.0 sq. ft.
Heating surface, total	3,012.7 sq. ft.
Grate surface	34.22 sq. ft.
Grate, style	Rocking; openings, ⅝ in. and 11/16 in.
Ash pan, style	Hopper, dampers front and back.
Exhaust nozzles	5¼ in., 5½ in., 5¾ in. diam.
Smokestack, inside diameter	18⅝ in. at top, 16 in. near bottom.
Smokestack, top above rail	14 ft. 10½ in.

Tender.

Weight, empty	37,800 lbs.
Wheels, number of	8
Wheels, diameter	33 in.
Journals, diameter and length	4½ in. diam. by 8 in.
Wheel base	15 ft. 3 in.
Tender frame	10 in. channel.
Tender trucks	2 trucks, 4-wheel side bearings on both trucks.
Water capacity	4,350 U. S. gallons.
Coal capacity	9 (2,000-lb.) tons.
Total wheel base of engine and tender	53 ft. 6½ in.

INTERNATIONAL RAILWAY CONGRESS.

Subjects to Be Discussed.

The next meeting of the International Railway Congress will be held in Paris, beginning September 15, 1900, at which the following subjects will be discussed:

Ways and Works.—Nature of metal for rails; rail joints; points and crossings; maintenance of way on lines with heavy traffic; methods of dealing with snow; construction and tests of metallic bridges; transition from a rising to a falling gradient; preservation of timber; ballast; creeping of rails.

Locomotives and Rolling Stock.—Exhaust and draught in locomotives; locomotives for trains run at very high speed; stability of locomotive axles; banking, piloting, or double heading; purification of feed water of locomotives and use of disincrustants; use of steel and ingot iron in construction of locomotives and rolling stock; brakes and couplings of carriages and wagons; economical size of goods trucks or capacity of freight cars; electric traction; automotor vehicle.

Traffic.—Train lighting; handling and conveyance of broken loads; long-distance goods trains; economical interlocking apparatus; automatic block system; signals for repeating visible signals; use of the telephone; safety appliances for preventing collisions arising from runaway wagons; sorting by gravitation; distribution of rolling stock.

General.—Accounts; railway clearing houses; grouping of goods; technical education of railway servants—appointment and promotion; co-operative societies and stores under railway management; facilities for customs inspection.

Light Railways.—Influence of light railways on national wealth; means of developing; main lines crossed by light railways; conveyance of farm produce to stations; carriages and wagons for light railways; warming of carriages.

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Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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We are not responsible for the poor character of some of the engravings in this issue. This is due to a strike among the engravers.

It has been a common error that a wide firebox necessarily meant an inordinately large grate. On this point Mr. Forsyth is very clear, on page 347, in our November issue. The advantage of greater width is that the necessary area may be obtained without excessive length. Whether the grate is large or small, the disposition of its surface is much better if it is not rigidly limited in width to the customary distance. There is no objection to, but rather a decided advantage in, a long firebox, because of its value as a combustion chamber, but it is not necessary to insist upon making the grates as long as the firebox.

It is interesting to compare the effects of Mr. J. Snowden Bell's paper on Wide Fireboxes before the Western Railway Club in 1895, with that of September last on Short Front Ends, before the same organization. Wider fireboxes are looked upon with greater favor, and for several reasons, which Mr. Bell has urged for a long time. The spark losses due to the draft which is necessary to use with an over-worked grate are beginning to be appreciated. The possibilities of reducing the proportions of the smoke nuisance, and possibly also the reduction of the number of staybolt breakages will all have their influence and a radical change of opinion as to the best shape for fireboxes is very probable. This must be gratifying to Mr. Bell, who has been ahead of his time on this subject.

In summing up the relative advantages of cast steel and wrought iron for locomotive parts where it is possible to use castings it has been said that the cost of machining the castings is so high as to increase the expense of castings above that of forgings. This criticism has been applied particularly to locomotive frames, but the reason for this is not clear. In fact, if frames are properly designed the cost of finishing may be the same in both materials or it may be even cheaper in steel. The amount of material to be removed in finishing may be reduced to a minimum by arranging the portions that are to be machined so that they will project above the other surfaces and the high ones only will be dressed. It is not necessary to finish the entire surface of a cast steel frame on this account, whereas a forged frame cannot be made with the finished portions projecting above the others without greatly increasing the cost of the forge shop labor. Well designed steel castings of good material do not break and there seems to be no reason for delaying to accept this material for frames. There is in fact good reason for using it.

It has been said in rather a blood-curdling way that a large number of first class and some second class funerals among traffic officials are necessary to a solution of the problem of a standard freight car in this country. It is probable, as Mr. Rhodes said last month before the Western Railway Club, that the solution will not be more difficult than those which have been the means of attaining the present standard air brake and freight car coupler and the financial benefits to be had from the really standard car are great enough to entirely overshadow these acquisitions, important as they are. Much hope may be had from the fact that motive power, operating and finally traffic officers agree in the desirability of this step and the result does not seem to be in quite the remote distance that it occupied a few years ago. The question interests all departments and the sincerity and perseverance of Mr. Rhodes which has done so much to develop the present standard air brake may be counted a powerful influence in this question. The Master Car Builders and the American Railway Associations have brought the problem forward and if traffic officials do their part the only remaining question will be to determine the dimensions. Difficult as this may be, it is to say the least, not worse than the question of couplers. The cross section of the car should be determined by the clearances of interchange roads and if the clearances on a few roads are found to limit the dimensions to an important extent for the whole country it is probable that the financial advantages to be gained will induce them to increase where it can be done without extraordinary expense.

"Shall we adopt yellow lights for the caution indication of distant signals?" is a question which is seriously troubling a number of operating officers who are seeking to improve their systems of signaling. The new color has been adopted by the New York, New Haven & Hartford and by the Canadian Pacific. Other roads have changed their semaphone castings and are ready to change from white to green, as an "all clear" signal. They are watching the results of the use of yellow for the distant signal, hoping to find it satisfactory. Opinion is not unanimous in favor of yellow, where it is in use, and several objections have been raised, among which is that it is not sufficiently distinctive and may be mistaken for a

smoky white light. We do not believe there is serious danger of red being mistaken for yellow, and if yellow is mistaken for red, no danger is involved. It has been said of the locomotive runners on the New Haven road and their favorable opinion of yellow signals, that they are so glad to have the green "all clear" signal that they are quite ready to put up with the disadvantages of the new color. This is probably the best way to look at the whole question of the change, viz., it permits of using the only safe color for "all clear," the disadvantages are not serious, and the men who use the signals are satisfied. In view of the glaring and often positively dangerous inconsistencies so often seen in railroad signaling, it seems strange that absolute perfection in the system of colors for night signaling should be considered a necessity. The yellow light is consistent and is a part of a logical system, the men who use it like it, there appears to be no trouble in using it, and it seems to be a plan which may be adopted with confidence.

LOCOMOTIVE STUDY IN TECHNICAL SCHOOLS.

There certainly is a revival of interest in technical school instruction in regard to the locomotive, and we are glad to print the communication by Mr. E. L. Coster, in another column, in which a suggestive criticism is offered. Our correspondent is connected with an engineering college, and after giving considerable thought to the subject, presents a view which will find ready endorsement. The locomotive requires special treatment. It is progressing, perhaps, more at the present time than at any period in its history, and by all means the technical school is the best place for future motive power officers to obtain their ideas as to the necessities and possibilities of the locomotive problem. This branch of engineering offers a wide field for good work, and the question is how to give students the best idea of it. We believe that the best educational preparation in this connection is a good course in mechanical engineering, with the addition of a generous amount of time to this special subject. This should include the application of engineering to the locomotive as a steam motor and the use of information obtained in other courses in regard to the strength of materials, applied to the peculiar conditions, but the subjects which appear to be most often overlooked are the possibilities and limitations which this rigorous service offers. The business questions of train operation should be brought in, and when this is done it is clear that the subject becomes one worthy of the best thought of those who are directing technical education. It is easy to run too far toward testing and too deep into past history, and it is difficult, in the time available, to go too far into principles and into correct practice in details. We speak of correct practice in details with feeling, because this is a phase of the subject which can be given at school better than anywhere else, and yet it is known that in some cases really bad practice is presented to students as illustrating how locomotives are built. The need is for instructors who thoroughly understand what is wanted in locomotives, who can show what ought to be done and what is done in the most successful examples. It is difficult to obtain such instructors, but we do not believe it to be impossible for the necessary knowledge to be obtained by men who have selected teaching as their vocation. Examples of such men who are very successful might be mentioned. It is necessary for the schools to first appreciate the importance of the subject and then to provide for the course with the broadness which its character demands. The remaining question is to arrange the course to give the best that school instruction can give in the time allowed. Several technical schools are now considering the problem in a promising way. We desire to heartily commend and encourage the movement.

CYLINDER POWER OF COMPOUND LOCOMOTIVES.

By G. R. Henderson.
Assistant Superintendent Motive Power, Chicago & Northwestern Railway.

There is one point in connection with compound locomotives that is seldom referred to, the ratio of tractive power to weight as compared with simple locomotives. Examination of a number of heavy two-cylinder compounds reveals the following values for the ratio $\frac{Pd^2S}{DW}$ when

P = steam pressure,
d = diameter of cylinder,
S = stroke of piston,
D = diameter of driving wheels,
W = adhesive weight,
all being expressed in pounds and inches:

Working Compound.	Working Simple.
.180	.315
.185	.270
.200	.295
.210	.310
.245	.360
.250	.350
.255	.370
.265	.385

These values were computed as follows:

Working simple: P = boiler pressure and d = diameter of high-pressure cylinder.

Working compound: $P = \frac{\text{Boiler pressure}}{\text{Cyl. Ratio} + 1}$ and d = diameter of low pressure cylinder.

The results are, of course, the ratio of theoretical tractive power to adhesive weight, and may be correctly used for making comparisons, though not for expression of actual pulling power. As long ago as 1887 a committee of the Master Mechanics' Association recommended that the above ratio be 0.26 for freight engines. However, with improved sanding apparatus, good results may be obtained with a ratio as high as 0.31, and there are many locomotives in use in which the ratio is from .28 to .30.

This being the case, it is at once evident that the simple locomotive has an advantage in power over the compound. The reason for this arrangement is also apparent when we remember that if we exceed the value 0.30, we get a "slippery engine," and this requires careful handling, so that most of the compounds above listed would be inclined to slip their wheels when starting or operating as simple engines. In some recent tests on heavy grades and curves with engines having ratios of 0.25 and 0.37, when working compound, the wheels would slip on curves; and when working simple, it was necessary to use sand on straight track. Of course the lever was in the corner and the engine was exerting its maximum power.

Now there are many cases where this is no disadvantage, but is perfectly satisfactory, and makes a logical arrangement For instance, let us consider a rolling profile with level stretches and an occasional hill of easy gradient to be passed. In this case the engine may be so loaded that it will be necessary to operate it as a single expansion engine in starting and ascending the grades, but on the levels it may be used in the compound position and in nearly full gear. The maximum tractive force will then be needed only at starting and passing the critical points.

But now let us take an entirely different condition, and assume that the engine is to be used exclusively in pusher service on a heavy mountain grade. In the course of its work it will be expected to pull every pound possible for perhaps an hour and then drop back down the hill light and possibly wait several hours for the next train to be made up. Under these conditions the tractive power should be fully up to the adhesion. If it is not, the weight of the engine is not fully utilized. In this service the simple engine with cylinders to give a tractive power (theoretical) of 0.31 of the adhesive weight

has decidedly the advantage. Of course our compound engine may be worked simple, but even if it is not too slippery for satisfactory performance the extra cost and mechanism of the compound feature is at least unremunerative. It is true that this simple engine will burn more coal than a compound, but if the case is as above represented it will be using steam but one-fourth or one-fifth of the time and the extra hauling capacity will probably be considered of more value than the saving in fuel. If compounds are insisted upon for such work it seems advisable to call attention to the fact that the cylinders should be proportioned to obtain the full advantage of the adhesion, when compounded, and some reducing valve or other arrangement provided, so that when working simple little or no increase in power will be experienced, but merely the proper steam admission obtained at both sides in order to enable the engine to start in any position of the cranks.

LOCOMOTIVE ROAD TESTS.

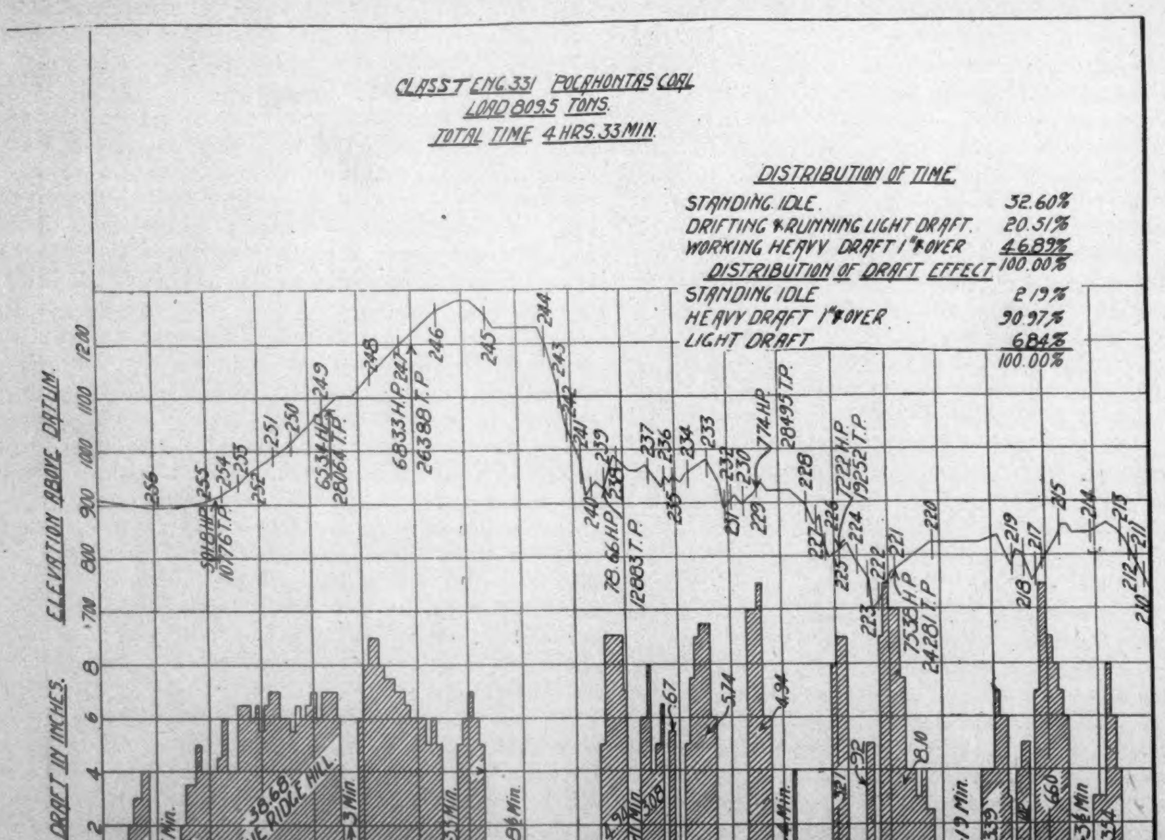
Norfolk & Western Railway.

Mr. W. H. Lewis, Superintendent of Motive Power.

We are indebted to Mr. W. H. Lewis, Superintendent of Motive Power, for the drawings of the piston valves shown on another page, and also for records of an interesting series of road tests for fuel consumption in several locomotives on the Blue Ridge Mountain grade, the chief object of which was to ascertain the relation between the fuel consumption and the work performed. The question was whether an increase in tonnage hauled would result in a decrease in the consumption of fuel burned per 100 ton miles. It would seem plain that any increase in tonnage beyond the economical rating of the locomotive must be at the expense of economy of fuel, and that a decrease of tonnage below the economical rating would be correspondingly wasteful, the point to be determined being the economical rating of the engine. It is evident that this depends upon local conditions to such an extent as to make it possible to ascertain this rating only on a given portion of the road. The actual economy of operation due to hauling the maximum possible loads was not considered in this work.

When the subject was first presented a theoretical solution was attempted by computing the tractive force and theoretical tonnage rating of a locomotive of given dimensions for certain grades and known rates of combustion per square foot of grate and heating surface and evaporation value per pound of coal. The steam used per hour was then calculated at various speeds with cut-offs at 30, 60 and 90 per cent. The results seemed to indicate that the coal consumption increased very rapidly with the increase of tonnage and was greatly in excess of the average number of pounds per 100 ton miles for the lesser lading. For example, a (Class G) engine, with 400 tons, on a 1 per cent. grade, at a speed of 10 miles per hour, consumed 27 pounds of coal per 100 ton miles, while with 600 tons the consumption was 39 pounds, and for 800 tons 56 pounds per 100 ton miles. In other words, doubling the tonnage more than doubled the consumption of fuel per 100 ton miles.

The report states that in order to test the correctness of this theoretical calculation it was decided to make a service test, selecting, first, a Class W engine, with 21 by 30-inch cylinders; weight of engine, 150,000 on driving wheels; drivers, 56 inches in diameter. Second, a Class T simple engine (with slide valves), cylinders 21 by 24; weight, 125,000 pounds; drivers, 56 inches in diameter. Third, Class T simple (with piston valves), cylinders, 21 by 24; weight, 125,000 pounds; drivers, 56 inches in diameter; and fourth, Class T compound, with cylinders 22½ and 35 by 24; weight, 125,000 pounds; drivers, 56 inches, with steam pressure of 200 pounds for all the engines. That portion of the road between Roanoke and Lynchburg (over the Blue Ridge Mountains), with a maximum grade of 66 feet to the mile, was selected. The engines were provided with indicators and vacuum gauges to record the amount of



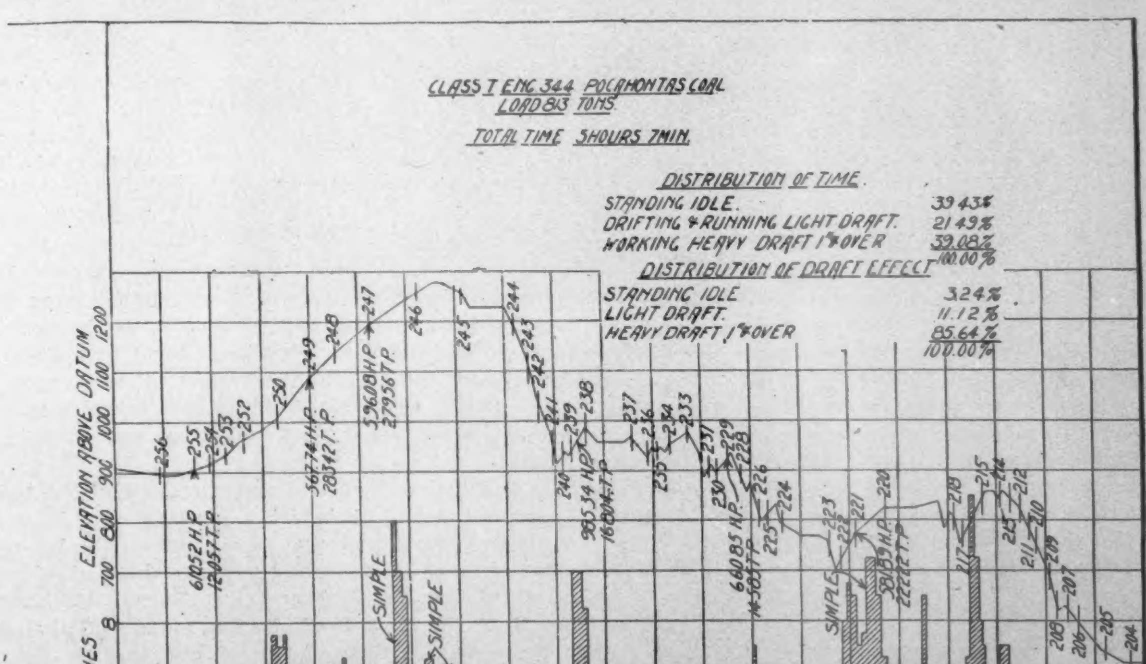
DRAFT CHART—SIMPLE LOCOMOTIVE WITH PISTON VALVES.

vacuum developed in the smokebox and water meters to record the water consumption. The loose coal in the coal space was accurately weighed and the surplus was sacked, each sack containing 100 pounds. As the water meters proved unreliable, the tank was calibrated and the readings were sufficiently accurate to insure reasonably correct results. Five preliminary trips were made with different tonnage to determine approximately the proper tonnage and to get everything in good working order. The plan outlined for the test was to first load the engine below the normal tonnage rating and gradually increase the rating each trip, keeping the conditions the same as nearly as practicable. The following is quoted from the report:

"Engine No. 809 (Class W), in good condition, was given a train of about 150 tons below the normal rating and tonnage increased on subsequent trips to about 100 tons above the normal rating. Duplicate trips were made with each tonnage to insure average results. A similar series of tests was made with each of the engines above mentioned, with the same engineman, fireman, conductor and brakeman, the train leaving at the same time each day, and train dispatchers gave the train as uniform movement as possible. The same tender was used on the different engines during the entire series of tests. Indicator diagrams were taken at eight points on the run, representing the ruling grades, to ascertain the tractive power and horse-power developed by the engine. In addition to indicator diagrams, readings were taken from the draught gauge in the front end at frequent intervals during the trip, noting the variations in the draught as the work of the engine ran from extreme conditions to that of drifting with the throttle closed. The changes in the draught gauge were noted according to time intervals, and the time also noted at the passing of each mile post. A graphical chart showing the amount of draught during the entire trip was compiled from these data, the chart showing the stops in minutes, and the lines enclosing the amount of draught carried on from minute to minute may be called the total draught effect, which, on the chart, is distributed to each pull. For instance, these charts show the amount of draught effect for a pull on Blue Ridge Hill to be in one case 44.9 per cent. of the entire draught effect for the entire trip, and we reasonably assume that very nearly that proportion of the entire coal burned from start to finish was consumed on that portion of the run, thus showing where the coal had been burned. This is taken on the proposition that the amount of coal burned must be in close relation to the amount of draught. It was proved by observation that this was approximately correct, as the amount of coal burned, by accurate measurement, corresponded very closely to the chart. The chart shows the tractive power and horsepower at the points where indicator cards were taken. The chart also shows a line produced by extending the mile posts to a scale height corresponding to their elevation on the road profile, thus producing a time interval profile which agrees with each draught effect. In other words, when the train is raised a known number of feet, in a given number of minutes, as shown on the profile, under this rise will be found the proportionate amount of draught necessary to overcome the resistance.

"It was found that a lading of 1,120 tons, exclusive of the weight of the engine and caboose, could be considered a full maximum load for Class W, 890 tons for Class T simple and Class T compound (two cylinder) up Blue Ridge grade; and it was found that with this lading, with the engine working at full stroke, the pneumatic sanding device was insufficient to hold the engine to the rail, and it became necessary to use the hand sanding device on the hardest pull. The engines were working at their maximum power, the tractive power exerted in some cases was as high as 27.6 per cent. of the adhesive weight of the engine, and as the highest usually considered available is about 22 per cent., it is plain that the engines were doing all that could be expected.

"The pounds of coal per 100 ton miles for two trips were .098 and .101, and for two others the pounds of coal were .121 and .117 respectively, an increase of about 20.2 per cent.



DRAFT CHART—RICHMOND COMPOUND LOCOMOTIVE.

coal burned per ton mile for an approximate increase of 10 per cent. in tons hauled.

"Referring to the draught effect diagrams, as stated above, it appears that 44.9 per cent. of the entire coal burned on this trip of 54 miles was consumed in a distance of 12 miles from Roanoke to the top of the Blue Ridge. It is plain that if the grade was uniform for the entire distance the consumption of fuel would have been more than four times the amount actually consumed. Realizing that the speed of the train was a very important factor, special effort was made to keep each trip as nearly a uniform speed as possible.

"Inasmuch as certain ruling grades between Roanoke and Lynchburg restricted the tonnage rating between these points so that it was impossible to increase the rating materially above the maximum rating without doubling, we decided to continue this test on the Norfolk Division, between Crewe and Lambert's Point (133 miles), where the low grade would permit of a greater over load in tonnage and would enable us to better observe the effect so far as fuel consumption was concerned. We selected Class T engine No. 326, the normal rating of which was 2,000 tons, over this portion of the road. Ten trips were made with this engine, starting with a tonnage of 2,016 and increasing gradually each trip until we reached a tonnage of 2,434 tons. This test developed the fact that while the total pounds of coal burned per trip increased slightly with the increase of tonnage, the pounds of coal per 100 ton miles was approximately unchanged, due to the fact that the profile of this division is a gradually descending grade in the direction of traffic, with a succession of short momentum grades, with very little level track, which permitted an acceleration through the depression sufficient to carry the train over the heavy pulls. This was made possible by the assistance given by the train dispatcher in making favorable meeting points and not stopping at stations where the grade was unfavorable.

"The conclusions derived from this test would seem to bear out the assumption that an increase in tonnage hauled beyond the normal or economical rating results in an increase in fuel burned per 100-ton miles, where the grades require that engines should be worked at from 30 to 90 per cent. cut-off, and that the amount of fuel burned is in direct proportion to the draught effect, and that carefully conducted service tests are the only reliable means for securing data for establishing the proper tonnage rating for locomotives."

The graphical diagrams of the draught effects are novel and were worked out by Mr. C. A. Seley, Mechanical Engineer of the road. The report includes a number of these, two of which are reproduced, one taken from the record of Class T engine No. 331, which is a simple engine with piston valves, and the other from engine No. 344, a Richmond compound. Comparing the charts taken from the two simple engines the differences appear to be chiefly due to the lading. The engine with piston valves seemed to do its work much easier than the other under all conditions, which is attributed to the reduced load on the valve gear, which resulted in better port openings. The chart of the compound illustrates a noteworthy feature in the relatively high degree of vacuum while drifting. It is evident that this compound was not fitted with the recent improvements instituted by the Richmond people and illustrated in our September issue. The draught while drifting is high when compared with that of the simple engine, running up to 2 and 3 inches, as compared with ½, ¾ and 1 inch for the simple engine. This results in unnecessarily active combustion and steam making when it is not desired, and in consequent loss. The compound was worked as a simple engine in several places, which are indicated on the chart.

These draught charts afford a very interesting method of analyzing the consumption of the fuel and we commend them for their novelty. From them the distribution of the fuel consumption may be studied, including the proportion of effect due to standing idle, working lightly and working hard. These curves show the relative amounts of work done on the hills and in descending grades. They also include the horse-power for each indicator card and the speed over even portions of the road.

These tests should not be misunderstood. They show an increase in the amount of fuel burned per ton mile unit when the engine is run at a point beyond the most economical cut-off, but this work treats of the fuel alone and does not take into consideration the operating questions. Certain charges are constant for a trip of 100 miles at 10 miles per hour, regardless of the train load. When these charges are considered, the greatest economy of operation is found when the engine is loaded to its full capacity, unless possibly the price of fuel should be abnormally high and train crew wages abnormally low. The operating question is the final one in such a case, and the increase of the fuel consumption, due to hauling heavy trains, may not be bad business policy, but it may be exactly the reverse.

RAILROAD SIGNALING.

Progress in railroad signaling is indicated to a certain extent by the relative amounts of attention given to the various topics of discussion at the recent annual meeting of the Railway Signaling Club, held in Boston. The subjects introduced by the papers presented were: Normal Safety vs. Normal Clear Systems of Automatic Signals, by A. J. Wilson; Progress in Signaling, by H. M. Sperry, and the Possibilities of Three-Position Semaphore Signals, by Frank Rhea.

Mr. Sperry's paper on progress in signaling was an admirable review of the state of the art, and was suggestive in regard to recent improvements in constructive details which should find general use in the future. It was the best paper presented and worthy of a thorough discussion which it did not receive, but it developed the fact that the most important subject in signal practice is that of the proper color for use at night on distant signals. The recent adoption of yellow for this purpose on the New York, New Haven & Hartford R. R., and the fact that the meeting was held in Boston offered an opportunity for the members to inspect the color under practical conditions which was taken advantage of.

The result was a favorable impression upon most of the members. The best opinions seemed to favor the new plan. Objection was made that yellow was not sufficiently distinctive; this, however, was not a source of danger, because it was possible that the new color would be mistaken for red under certain combinations of atmosphere and distance, but it was not likely that a red light could ever be mistaken for yellow. At short and even moderately long range, however, the distinction was sufficient, even if in doubt at a distance. The mistakes would therefore be likely to occur upon the safe side. This is the ground that we have taken in regard to the yellow distant signal light, and it was confirmed by the discussion.

It may therefore be said that the cause of the yellow light has gained ground. It is highly important that the color should be exactly right and that the glass should be made with extreme care. In connection with the shade of color it should be stated that Mr. C. Peter Clark, General Superintendent of the N. Y., N. H. & H. R. R., has found that the enginemen prefer a decided tinge of red in order that there may be no question of the doubt being on the right side in case of thick weather. The new color has not yet gone through a winter, and it is possible that valuable experience may be had by viewing it through snow.

The first of the papers introduced the question whether block signals should stand at "danger" positions or at "safety" under normal conditions with the track governed by the signals unoccupied and ready for a train to proceed. To the enginemen there is practically no choice, because with both systems properly installed and in working order, they cannot see any differ-

ence. It was argued that the normal danger had two decided advantages. First, the signals were liable to freezing up in sleet storms and it was safer to have them held in the danger position, and if they stood normally at "all clear" they might freeze and give misleading information of a dangerous character. Second, the signals are held at "all clear" by the battery currents, and there was an important economy in battery material and supplies in the normal danger system in which the batteries were only used while the signals were held at "all clear" for the passage of trains.

The discussion showed no lack of positive opinion, but it was clear that those who had but one system favored it, and considered it the safer and better, while those who had both favored the normal danger plan because it was consistent with the principle followed as far as possible in mechanical interlocking. One seeking information as to which system is best would get no help but would feel free to use either in the confidence that he had the support of well-formed opinion.

Other subjects were discussed, but these are not only the most important, but the most interesting to motive power men.

COMPRESSED AIR LOCOMOTIVE.

H. K. Porter & Co.

The accompanying engraving is from a photograph of a compressed air locomotive, built for the Aragon Mine, Norway, Mich., by H. K. Porter & Co., of Pittsburg.

The new plant, as installed for the Aragon mine, to replace haulage by mules, consists of a three-stage air compressor having a steam cylinder 14 by 16 inches. The air cylinders are 10½, 7¾ and 2⅝ inches in diameter. The compressor, at normal speed, will compress 125 cubic feet of free air per minute to 800 pounds pressure, and is connected to two storage tanks, 3 by 17 feet, from which the compressed air is carried down a shaft 750 feet, through a 3-inch pipe, thence to charging stations placed at convenient points in the mine, making the longest haul for round trip about 4,000 feet, and the shortest about 1,200 feet.

Compressed Air Locomotive.
Built by H. K. PORTER & Co.

The weight on drivers of the locomotive is 14,000 pounds; it has four driving wheels 24 inches in diameter, and cylinders 7 by 12 inches. The air pressure from the locomotive tank is reduced from 700 pounds to 140 pounds, the required working pressure. The locomotive is capable of pulling on a level with one charge of air, a train of 30 tons for a distance of 4,500 feet, and it will return with 10 tons, the weight empty. The maximum power of the motor, on level mine track, is 100 tons. Four trains of 20 cars each can be run every ten hours from the ten different points of the mine, making a hauling capacity of 1,000 tons in ten hours. The following table gives the dimensions of the locomotive:

Gauge of track	23 in.
Drivers	24 in.
Cylinders	7 by 12 in.
Main rod	47 in. long.
Weight on drivers	14,000 lbs.
Wheel base	48 in.
Length over all	13 ft.
Height over all	62 in.
Width over all	50 in.
The motor to work on curves of	20 to 25 ft. radius.
Air tanks, one	36¼ in. outside diam.
Steel	Shell, ⅜ in.; heads, 1⅛ in.
Joints, longitudinal	Butt, double welt, octuple riveted.
Joints, transverse	Lap, double riveted.
Auxiliary reservoir, capacity	1.6 cu. ft.
Auxiliary reservoir, working pressure	140 lbs.
Main reservoir, working pressure	700 lbs.
Main reservoir, capacity	65 cu. ft.

The torpedo boat destroyers, with Parsons steam turbines, which are now being built for the English navy, will be 210 feet long between perpendiculars. Their extreme beam will be 21 feet and moulded depth 12 feet 9 inches. The displacement at a draught of 5 feet 4 inches will be 320 tons. The propeller shafts will be four in number, each having two screws, and operated by two separate sets of turbines. The outer shafts will be driven by high-pressure and the inner ones by low-pressure turbines. The inner shafts will also have small reversing turbines, to drive the boats astern. The total power will be 10,000 indicated horse-power, which is expected to give a speed of 35 knots while going ahead and 16 knots while going astern. The auxiliaries for the air pumps will be turbines and the circulating pumps will be driven by reciprocating engines. The weight of the boilers will be 100 tons, 15 cwt., that of the machinery in the engine room 52 tons, 6 cwt., and that of the propellers and shafting 7 tons, 14 cwt. This will give a weight of machinery and boilers of about 30 pounds per indicated horse-power. The corresponding weight per indicated horse-power in recent boats of this class, with reciprocating engines, is about 54 pounds.

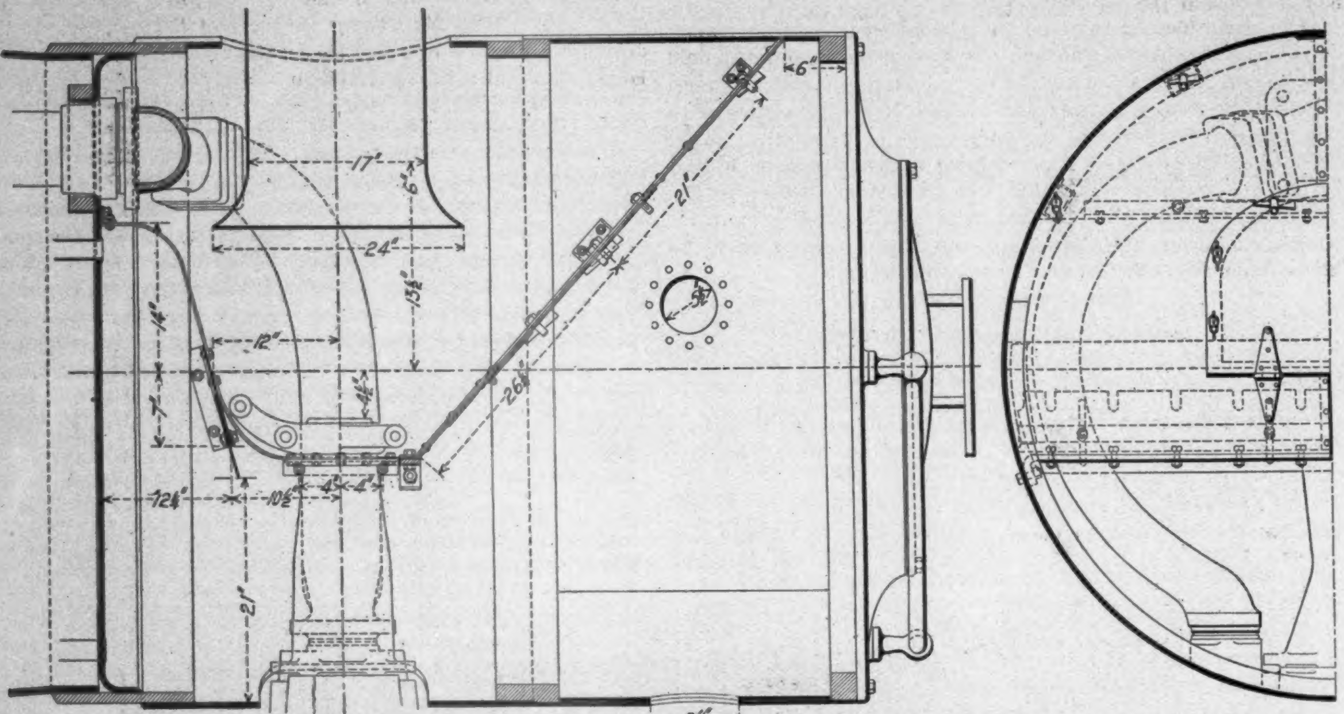
When scrap steel rails are worth more than new rails just from the rolls the condition of the rail market may be considered peculiar. Of course new rails are always worth more than old ones, but it is a curious fact that one large rail concern in Pennsylvania is now furnishing rails to a railroad on an old contract, entered into before the advance in prices, at $19.00 per ton, and the same road is furnishing old steel rails to the steel works at $21.00 per ton.

Just as we go to press a despatch is received stating that one of the new 10-wheel passenger locomotives of the Lake Shore & Michigan Southern (see November issue, page 343), made a run, November 24, of 186 miles from Buffalo to Cleveland, in 3 hours, 23 minutes, with 8 cars, making 5 stops between the terminals.

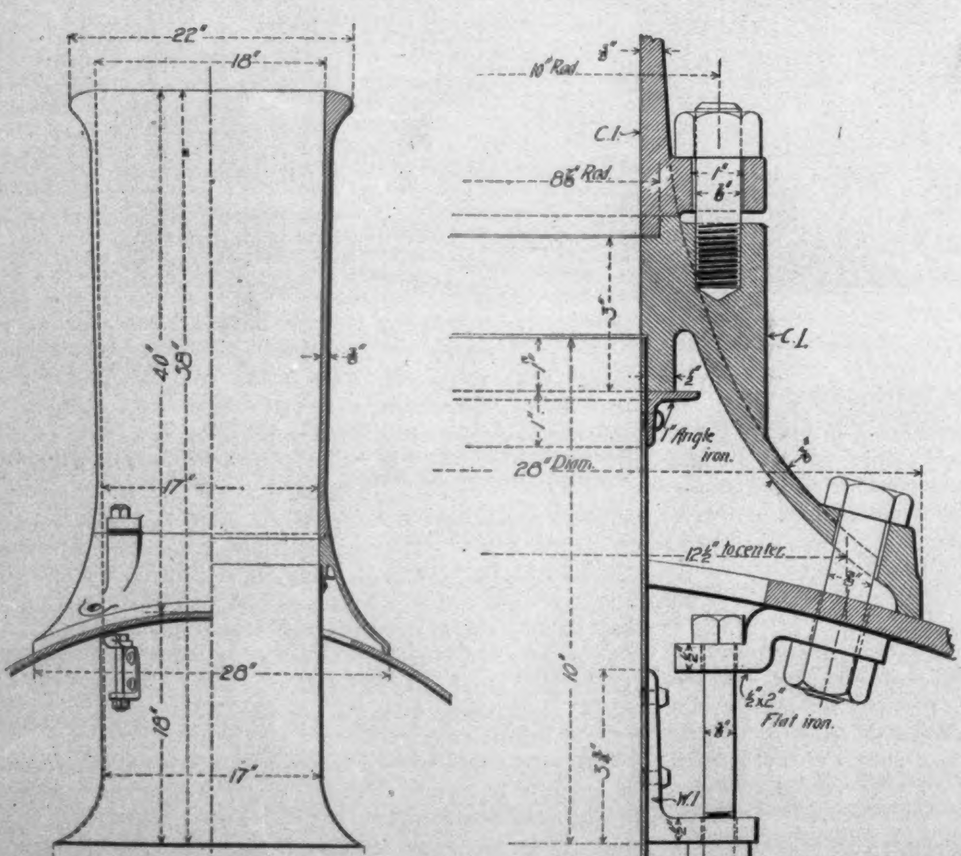
FRONT END ARRANGEMENTS WITH SHORT STACKS.

In spite of the favorable reports of the operation of the Master Mechanics' Association recommendations with regard to the arrangement of the front ends of locomotives, including the stack, exhaust nozzles and diaphragm, it is becoming clear that other and very different arrangements are giving good results, and in some cases where the Master Mechanics' plan has been tried and failed. This plan, as far as we know, has always resulted in sufficient vacuum, but notwithstanding that a high vacuum was obtained in the case we are to describe, the engine would not steam. It is not easy to find a reason why good steaming does not always accompany a good vacuum, but there is no doubt that this is sometimes the case.

The front end arrangement described by aid of the accompanying engravings is specially interesting because it is in



A Successful Front End Arrangement Used with Short Stacks.



Details of Smoke Stack and Its Extension.

perfectly successful use on a large number of fast and heavy passenger locomotives on a leading road and because it is entirely different from the Master Mechanics' recommendation. Further than this, it was found that the recommended plan was an absolute failure on these engines, although it gave a vacuum of 10 inches of water when running at high speed. The drawings show an extended smokebox and a 17-inch stack and it will be noted that the stack is comparatively low, as it must be necessarily in the case of large engines. These are of the 8-wheel type, and are large engines.

This front end was the result of a large number of trials which were made to overcome indifferent steaming. It was found to be successful in the summer of 1895 and is now in general use on the road referred to on various different types of engines. As originally arranged the engine was equipped with a petticoat pipe extending from a point near the base of the stack for some distance into the smokebox. During

the trial of the petticoat pipe it was found that the exhaust was very jerky and intermittent, and on comparing the results with those of older engines, which did steam well, the only factor which seemed to have much bearing on the question was that in the older engines, which were low, the stack was materially longer and apparently the exhaust went through and beyond the short stack without completely filling it. When the petticoat pipe was removed and the length of the stack increased, an improvement in the action was immediately noticeable, so great an improvement having been secured as to lead to the decision not to return to the use of the petticoat, no matter what the service or type of the engines.

The simple facts in the case are stated here without attempting an explanation or suggesting a criticism of the excellent work of the Master Mechanics' Association Committee. It seems proper to draw the conclusion, however, that the petticoat pipe does not make up for the detrimental effect of a short stack. Support for this conclusion is given by recent experience with some large compound locomotives with which a great deal of difficulty was experienced when running slowly, owing to the intermittent effect of the exhaust. These compounds were fitted with petticoat pipes when they gave this trouble and when changed in accordance with this idea they were entirely satisfactory.

The drawing shows an extension of the stack downward into the smokebox, with a flaring mouth, or a union of a petticoat pipe and stack, with no open space between them. The drawings do not require explanation as they show the front end and also the stack, giving its form, diameters and height. This arrangement is found to be almost perfect in its self-cleaning qualities, hardly a quart of cinders being found in the smokebox after a long run. The area of the netting is large and the draft is found to be uniformly distributed over the flue sheet. The stack extension is not by any means a new idea, but it probably never before had such an opportunity to show its importance as at present, with large boilers and short stacks.

In a letter received after this description was written, Mr. J. Snowden Bell said: "I quite agree with those who hold that the inward extension of the stack is the coming plan, and indeed it seems indispensable with the present large and high boilers. The fact, however, is that the difficulties due to the shortening of stacks were appreciated long prior to 1895." Mr. Bell puts the date at 1860 in his recent paper before the Western Railway Club.

PERSONALS.

F. E. Clark, President of the Boston & Lowell, died very suddenly at his home in Lawrence, Nov. 7, aged 69 years.

Mr. A. B. Pirie has been appointed Master Mechanic at the Havelock Shops of the Burlington & Missouri River Railroad.

Mr. W. H. Harrison, Master Mechanic of the Baltimore & Ohio, stationed at Newark, O., has resigned and will go to Chicago.

Mr. C. R. Tunks has been appointed Master Car Builder of the Lake Shore & Michigan Southern, with headquarters at Adrian, Mich.

Mr. Robert S. Bradley has been elected President of the Central Massachusetts, in place of Mr. Samuel H. Aldrich, who declined a re-election.

Mr. Le Grand Parish has been appointed Master Car Builder of the Lake Shore & Michigan Southern, at Englewood, vice Mr. A. L. Kendall, resigned.

F. J. Kraemer has been appointed Master Mechanic of the Southern Division of the Burlington & Missouri River, with headquarters at Wymore, Neb.

Mr. Lawrence K. Frederick has been elected Vice-President and General Manager of the Erie and Central New York Railroad Company, with headquarters in Cortland, N. Y.

Mr. O. H. Jackson, Superintendent of Motive Power of the Phenix, Santa Fe & Prescott, has resigned on account of ill health and has returned to New York City to reside.

Mr. D. F. Crawford has been appointed Superintendent of Motive Power of the Pennsylvania lines west of Pittsburg, Northwest system, to succeed Mr. G. L. Potter, promoted. Mr. Crawford has heretofore been Mr. Potter's assistant.

Mr. J. J. Hill, President of the Great Northern Steamship Company, has resigned his position with this company and Mr. Darius Miller, Second Vice-President of the Great Northern, will succeed Mr. Hill as President of the steamship company.

William F. Durfee died in the State Hospital at Middletown, N. Y., Nov. 14th. Mr. Durfee was one of the pioneers in the development of the iron and steel industry in the United States. He was a member of the American Society of Mechanical Engineers, of which he had been a Manager from 1883 to 1886 and Vice-President from 1895 to 1898.

Vice-President Hall, of the New York, New Haven and Hartford, has been elected President of that company, to success Mr. C. P. Clark, resigned. President Hall is fifty-eight years old; he graduated at Yale College in the class of 1866, after taking very high literary honors. He graduated at Columbia Law School in 1868, and was admitted to the New York bar in the same year. He was appointed a Judge of the Supreme Court in 1889, and would probably have been promoted to the Supreme Bench but for his resignation of his Judgeship in 1893 to take the first Vice-Presidency of the New Haven Railroad, which he has held up to this time.

Mr. G. L. Potter, heretofore Superintendent of Motive Power, Pennsylvania Lines West of Pittsburg, Northwest system, has been promoted to the newly created office of General Superintendent of Motive Power, Pennsylvania Lines, with headquarters at Pittsburg. Mr. Potter reports to the General Manager, and has the direct supervision and control of the motive power department in so far as is necessary to insure the efficiency of the equipment. He has charge of all tests and experiments, and directs the various shops and makes such recommendations to the General Manager or direct to the Superintendents of Motive Power, as he deems necessary for the efficiency and economy of the service. This outline of his new duties is taken from the official announcement of his appointment.

Mr. L. R. Pomeroy, who is well known as the representative, in the East, of the Cambria and the Latrobe steel companies, has resigned this position, which he has filled for the past seven years, to become Assistant to the General Manager of the Schenectady Locomotive Works. Mr. Pomeroy spent about twelve years in accounting work and in 1886 became Secretary and Treasurer of the Suburban Rapid Transit Railway of New York City, which afterward became a part of the Manhattan system. He spent two years in the sales department of the Carnegie Steel Co., after 1890, and then took up the representation of the two companies, which he now leaves. He has been very successful in his work, and has had an important influence in securing improved practice in locomotive details, with particular reference to axles, piston rods and crank pins. His accounting experience, wide acquaintance and knowledge of locomotive practice will make him a valuable officer to the Schenectady Locomotive Works, and it will be difficult to fill his position with the firms whose employ he leaves.

Mr. O. H. Reynolds, who is well-known to the readers of this journal, has been appointed Mechanical Engineer of the Dickson Locomotive Works at Scranton, Pa. His ability and experience in the motive power departments of important railroads, coupled with clear ideas of locomotive design and thorough knowledge of shop methods and operation of locomotives on the road, render the selection a wise one. He is a safe and intelligent designer and will be a valuable addition to the staff which he joins. That railroads need men of his experience and qualifications is the greater reason for congratulating the Dickson people. Mr. Reynolds began railroad work as an apprentice in the shops of the Michigan Central, where he remained for several years after completing the apprenticeship. His most important railroad work was on the Northern Pacific as Mechanical Engineer, a position which he filled for several years. He came to New York about three years ago to join the editorial staff of "Locomotive Engineering." After severing his connection with that journal he assisted in editing the "American Engineer and Railroad Journal" until he was called to the motive power department of the Central Railroad of New Jersey, which he leaves for his present position at Scranton.

Schenectady, Consolidation Pushing Locomotive, Delaware & Hudson Co.

CONSOLIDATION PUSHING LOCOMOTIVE.

For Fine Anthracite Coal.

Delaware & Hudson Company.

Exceptionally Powerful Boiler for the Weight.

This locomotive is one of six built by the Schenectady Locomotive Works for the Delaware & Hudson Company, and used in pushing service. The design resembles in appearance the one illustrated in our August issue, page 247, but the new ones are very much heavier and more powerful. They are to burn fine anthracite coal and have very large grates, with 90.19 square feet of grate area. The cylinders are 22 by 28 inches, and the driving wheels, which are of cast steel, are 50 inches in diameter. The driving wheels are not of the same weight, the main wheels being made heavier and stronger than the others. The rods are of light and fluted section, the driving axles have enlarged wheel fits, and the frames are of cast steel. The details are not novel, but the real feature of the design is in the very large heating surface in view of the limit of the total weight of the engine. The total weight was limited to 176,000 pounds, and efforts were made to secure as much heating surface and grate area as possible without exceeding the limit. The total heating surface is 3,348 square feet, which, with the exception of the Baldwin compounds for the Lehigh Valley (American Engineer, December, 1898, page 395), and the mastodon for the Illinois Central (October, 1899, page 315), is the largest total heating surface in locomotive practice of which we have record. The very large consolidation locomotive for the Union Railway has a total heating surface of 3,322 square feet, with an 80-inch boiler, and a total weight of 230,000 pounds; the new mastodon for the Illinois Central has 3,500 square feet, with an 82-inch boiler, and a total weight of 232,200 pounds, while the Lehigh Valley compounds have 4,105 square feet, with an 80-inch boiler, and a total weight of 225,000 pounds. These figures are assembled, for convenience, in the following table:

COMPARISONS OF WEIGHTS AND HEATING SURFACES.

	D. & H. Co. Consolidation.	L. V. R. R. Consolidation.	I. C. R. R. Mastodon	Union Ry Consolidation.
Total Weight	176,00 lbs.	225,000	232,200	230,000 lbs.
Weight on Drivers	157,500	202,232	193, 200	208,000 lbs.
Heating Surface Tubes	3,036.26 sq. ft.	3,890 sq. ft.	3,237 sq. ft.	3,116.5 sq. ft.
Heating Surface Firebox	312.28 sq. ft.	215 sq. ft.	263 sq. ft.	205, sq. ft.
Heating Surface Total	3,348.54 sq. ft.	4,105 sq. ft.	3,500 sq. ft.	3,322 sq. ft.
Tubes, Number	417	511	424	355
Tubes, Diameter	2 inch	2 inch	2 inch	2¼ in.
Tubes, Length	14 ft. 0 in.	14 ft. 7¾ in.	14 ft. 8⅝ in.	15 ft. 0 in.

The firebox heating surface of the D. & H. engines is very large, and, we believe, larger than ever before used on a locomotive. This will be advantageous with fine anthracite coal. The statement of these facts shows this design to be a notable one. The very large boiler capacity ought to give good account of itself in producing abundant steam and with very satisfactory economy. The table of dimensions follows:

General Dimensions.

Gage	4 ft. 8½ in.
Fuel	Fine anthracite coal
Weight in working order	176,000 lbs.
Weight on drivers	157,500 lbs.
Wheel base, driving	16 ft.
Wheel base, rigid	16 ft.
Wheel base, total	24 ft. 2 in.

Cylinders.

Diameter of cylinders	22 in.
Stroke of piston	28 in.
Horizontal thickness of piston	5½ in.
Diameter of piston rod	3¾ in.
Kind of piston packing	Cast iron
Size of steam ports	18 in. by 1¼ in.
Size of exhaust ports	18 in. by 2¾ in.
Size of bridges	1⅛ in.

Valves.

Kind of slide valves	Richardson balanced
Greatest travel of slide valves	5½ in.
Outside lap of slide valves	¾ in.
Inside lap of slide valves	1 line and line
Lead of valves in full gear	Line and line F. & B.

Wheels, etc.

Diam. of driving wheels outside of tire	50 in.
Material of driving wheel centers	Cast steel
Tire held by	Shrinkage
Driving box material	Cast steel
Diam. and length of driving journals	9 in. diam. by 10 in.
Diam. and length of main crank pin journals (main side, 7 in. by 5¼ in.)	6½ in. diam. by 6 in.
Diam. and length of side rod crank pin journals (inter., 5½ in. by 4¾ in.) F. & B.	5 in. diam. by 3⅝ in.
Engine truck, kind	2-wheel swing bolster
Engine truck journals	6 in. diam. by 10 in.
Diam. of engine truck wheels	30 in.
Kind of engine truck wheels	Steel tired spoke center

Boiler.

Style	Straight, with wide firebox
Outside diam. of first ring	74 in.
Working pressure	180 lbs.
Material of barrel and outside of firebox	Carbon steel
Thickness of plates in barrel and outside of firebox	⅝ in. by 9/16 in.
Firebox, length	120 in.
Firebox, width	108 in.
Firebox, depth	Front at center, 71 in.; back, 61½ in.
Firebox, material	Carbon steel
Firebox plates, thickness	Sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube sheet, 9/16 in.
Firebox, water space	Front, 3½ in.; sides, 3 in.; back, 3½ in.
Firebox, crown staying	Radial 1 in. diam.
Firebox stay bolts	⅞ in. by 1 in. diam.
Tubes, material	Charcoal iron No. 11
Tubes, number of	417
Tubes, diameter	2 in.
Tubes, length over tube sheets	14 ft.
Heating surface, tubes	3,036.26 sq. ft.
Heating surface, water tubes	86.75 sq. ft.
Heating surface, firebox	225.53 sq. ft.
Heating surface, total	3,348.54 sq. ft.
Grate surface	90.19 sq. ft.
Grate style	Water tubes, dead bars and drop bars
Ash pan, style	Hopper dampers front and back
Exhaust pipes	Double high
Exhaust nozzles	3⅜ in, 3½ in. and 3⅝ in. diam.
Smoke stack, inside diameter	16 in.
Smoke stack top above rail	14 ft. 11¼ in.
Boiler supplied by	2 injectors, Nathan & Co. monitor

PROMISING ATTACK ON THE LOCOMOTIVE SMOKE PROBLEM.

It may be possible to entirely overcome the production of smoke by locomotives using smoky fuel. It is practicable to greatly reduce this evil and because information is necessary to the application of any improvement the recent action of the Western Railway Club in appointing an able committee on this question is promising and also commendable. Soft coal must be used to a large extent and often poor coal at that. There are many devices for which great advantages are urged and it may be possible to obtain marked improvements by their use. Greater care in firing will do its part and the probable extension of the use of large grates will also help. Careful consideration of the subject and a study of the conditions which result in the present difficulty cannot fail to lead railroads to do all that is in their power to obviate it, but it is a most difficult problem.

It has been demonstrated that soft coal may be burned in stationary practice with practically no smoke and with a gain rather than loss in efficiency. High furnace temperatures are necessary and there must be plenty of space for combustion, so that the gases shall not be brought into contact with the heating surfaces to be chilled before the combustion of the hydrocarbons is complete. The volatiles must be evolved slowly, and for this large grate areas are necessary and the coal must be fired in small quantities. It is also important that the air supply should be sufficient to combine with the volatiles as they form. It has been found very advantageous to divide the furnace into two parts so that one may be fired at a time and while one side is cooled by fresh coal the other side is at its highest temperature and is in condition to send hot gases to the bridge wall to mix with and consume the volatiles as they are given off most rapidly by the other side. Grates should have ample air spaces and means for keeping the bottom of the fire clean.

These are believed to be the conditions which are most likely to bring about the desired result in steam boiler practice of any kind, and as many as possible should be applied to the locomotive, but the limitations are rigid. It is possible to apply special furnaces to stationary plants and to obtain plenty of fire-box room, and the use of automatic stokers is easy, but when with all of these factors used to their best advantage the smoke is not altogether prevented, too much must not be expected from the locomotive with its extraordinary rates of combustion and the sudden and extremely great variations in the demands for steam.

Every road has a lot of old engines which present necessities have outgrown and yet representing a large investment. These present a special feature of the problem, which will not be reached by improvements in construction. This is probably the field for combustion devices, and also one for improved firing. The activity of municipal smoke inspectors, and the natural desire to make travel more comfortable and to abate a nuisance, will lead to greater efforts to build new engines so that they will smoke as little as possible, and the evident tendency toward wider fireboxes with perhaps also the use of two fire-doors, where they may be put in, may be expected to help in this direction.

The committee is to investigate a very old subject, but this is believed to be the first important systematic, concerted attack on the question as concerns the locomotive. It is hoped that everyone having information or facts from experience will offer them to this committee, Messrs. G. R. Henderson, R. A. Smart, J. C. McMynn, R. D. Smith and J. W. Luttrell.

A LARGE SIX-COUPLED SWITCHING LOCOMOTIVE.

The Baldwin Locomotive Works have recently completed a very large switching locomotive for the Cambria Steel Co., and by the courtesy of the builders we show a photograph.

Powerful Switching Locomotive for the Cambria Steel Co.

Built by THE BALDWIN LOCOMOTIVE WORKS.

This is the largest of its type that these works have produced, and we do not know of any other exceeding it. The general dimensions are as follows:

Cylinders.	
Diameter	21 in.
Stroke	26 in.
Valve	Balanced
Boiler.	
Diameter	68 in.
Thickness of sheets	11/16 in.
Working pressure	180 lbs.
Fuel	Soft coal
Firebox.	
Material	Steel
Length	108⅛ in.
Width	42 in.
Depth, front	65¾ in.
Depth, back	62¾ in.
Thickness of sheets, sides	⅜ in.
Thickness of sheets, back	⅜ in.
Thickness of sheets, crown	½ in.
Thickness of sheets, tube	½ in.
Tubes.	
Number	323
Diameter	2 in.
Length	10 ft. 5 in.
Heating Surface.	
Firebox	169.7 sq. ft.
Tubes	1,738.3 sq. ft.
Total	1,908.0 sq. ft.
Grate area	31.57 sq. ft.
Driving Wheels.	
Diameter outside	50 in.
Diameter of centre	44 in.
Journals	9 in. by 12 in.
Wheel Base.	
Driving	11.0 ft.
Total engine	11 ft.
Total engine and tender	39 ft. 7 in.
Weight.	
On drivers	137,080 lbs.
Total engine	137,080 lbs.
Total engine and tender	218,000 lbs.
Tender.	
Diameter of wheels	30 in.
Journals	4¼ in. by 8 in.
Tank capacity	4,000 gals.
Weight empty	34,000 lbs.

COLUMBIAN ELECTRIC CAR LIGHTING SYSTEM.

A system of railroad car lighting by electricity, deriving the power from the axle, has been developed and improved by the Columbian Electric Car Lighting and Brake Company, 11 Broadway, New York. The features of the system are illustrated in the accompanying engravings.

The essentials of the system are the generator, a storage battery for furnishing current while the car is standing at stations, and the automatic devices for providing for the reversal of the direction of the motion of the generator and the regulating device for cutting out the generator at low speeds and for maintaining a constant voltage under varying speeds. The system is arranged so that the lamps take current from the generator at speeds above 20 miles per hour, and the surplus not needed for the lamps goes into the storage battery, which, in usual working, is always charged nearly or fully up to its capacity and is called on to furnish current only when the generator is cut out by the automatic switch. The system differs from those which employ one battery for the lamps while a second battery is being charged by the generator, and in the Columbian system the battery is very seldom, if ever, fully discharged. In one case a battery was found ready to supply full voltage to the lamps after the car had been lying idle on a yard track for six months. In using but one set of accumulators in this way their capacity need not be large, which is an important item.

The generators are of the bipolar type, with shunt winding and steel magnetic circuits. They are enclosed in dust proof cases and are mounted on the trucks, as shown in Figs. 1 and 2, with a nose piece carried in a stirrup under the truck frame, while the chief portion of the weight comes upon the axle. The axle is fitted with a split sleeve, the ends of which are gripped to the axle by means of a form of chuck which permits of securing perfect centering of the sleeve and rigid connection to the axle whether it is rough or turned. Bearing rings running in grooves in the sleeve carry the generator. The end of one of the chucks appears at the left in Fig. 3. The

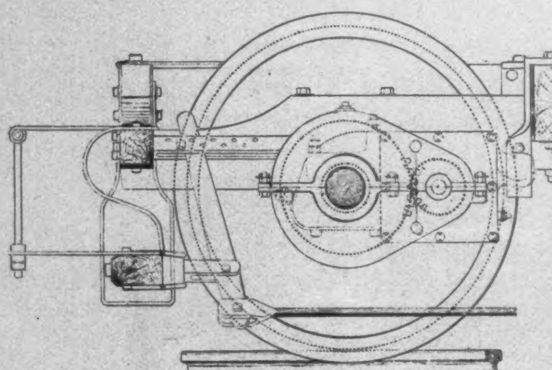


Fig. 1.

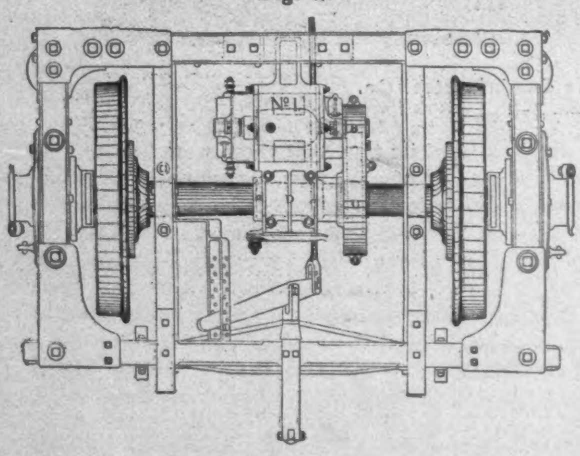


Fig. 2.

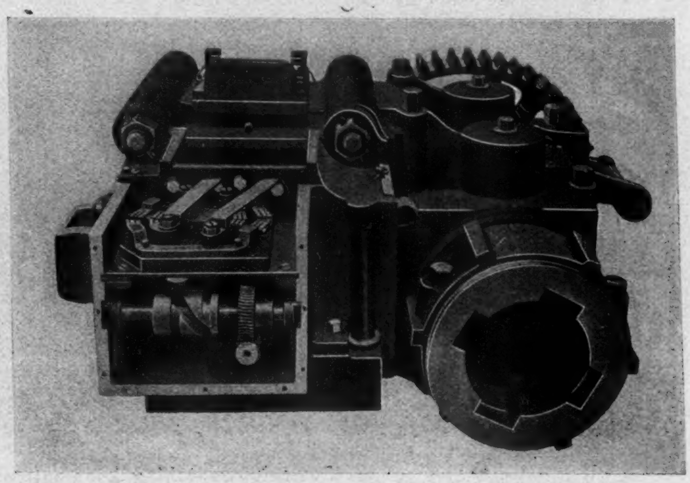


Fig. 4.

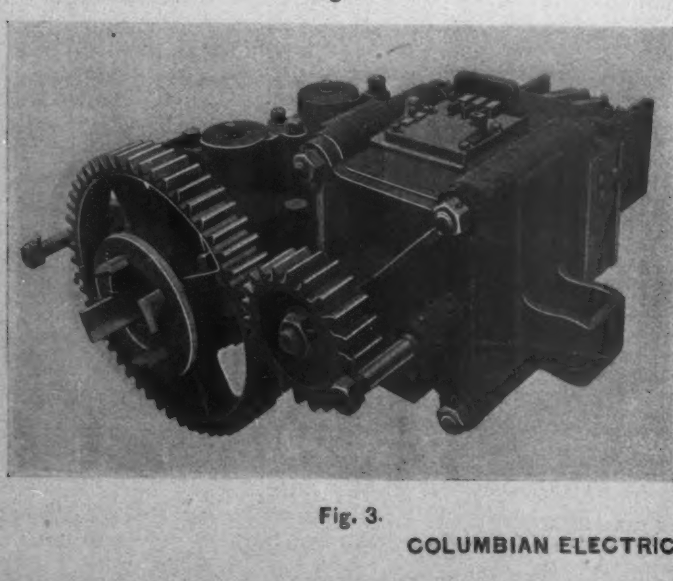


Fig. 3.

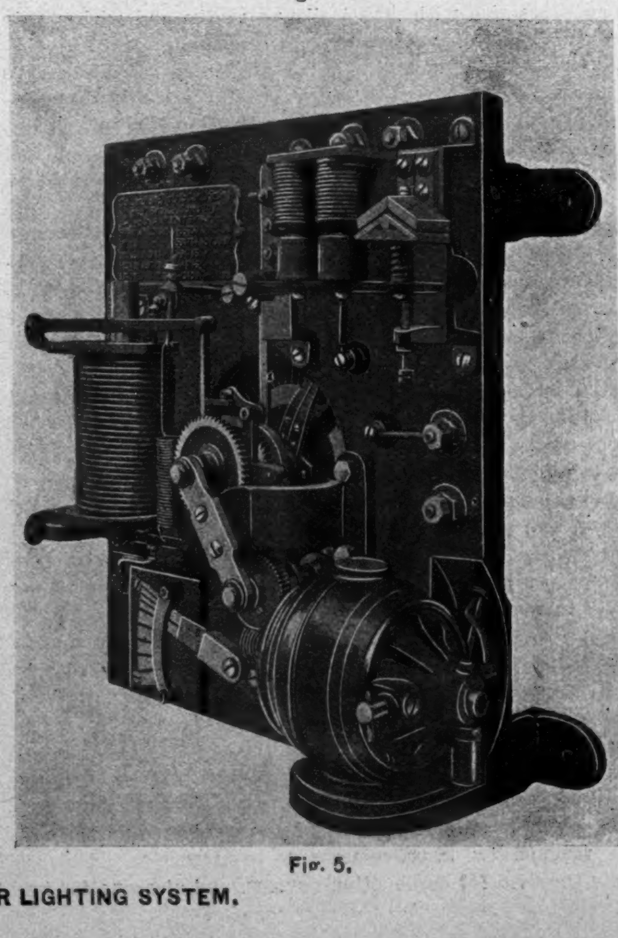


Fig. 5.

COLUMBIAN ELECTRIC CAR LIGHTING SYSTEM.

generator support at the sleeve is made by means of spring buffers, appearing on top of the axle in Figs. 3 and 4.

The ingenious pole changing device appears in Fig. 4. The end of the dynamo shaft carries a worm which drives a short horizontal shaft upon which a reverse, screw thread, cylindrical cam is mounted. The pole changing switch has six points and the direction of the current is changed upon the reversal of the direction of motion of the car by means of a pin which engages the cam thread below the switch. This pin is pressed into the slot in the cam by a spring, and the slot changes in depth in such a way as to throw the pin to the opposite end of the threaded slot upon the reversal of the direction of motion of the cam. This feature is shown in the photograph, but is obscured by the necessary reduction in the engraving. It is sufficient to say that the pole changing is accomplished mechanically without requiring any attention.

The regulating devices are assembled on a stand which is secured to a partition in a convenient part of the car. They accomplish two things. First, the cutting in of the generator when the required speed is reached, and second, the automatic regulation of the voltage, which is done by controlling the strength of the field. The cut out is controlled by the V-shaped switch shown in the upper right hand corner of Fig. 5. The switch is operated by double magnets, the lower pair of which are connected across the terminals of the armature and are shunt wound. The others are series wound and form a part of the circuit between the dynamo and the accumulators when the switch is closed. The voltage of the generator rises as the speed increases, when the train is started, and when it reaches the limit determined upon, the switch is closed. The voltage of the generator is then the same as that of the battery and the switch is held closed by the current from the generator to the battery. Upon the reduction of speed to the point at which the machine current can not balance that from the battery, the current reverses and the battery current permits the switch to open.

The regulation of the voltage in the lamp and battery circuits is obtained by aid of a small motor mounted at the lower right hand corner of the board (Fig. 5). This motor is always running and by means of worms and worm wheels it furnishes the power for moving the arm of the regulating rheostat. This arm is thrown into action with one or the other of two ratchets driven in opposite directions, the connection with the ratchets being controlled by a solenoid which is placed in the circuit between the generator and the battery. The rheostat controls the strength of the generator field. When the speed of the generator rises, tending to increase the voltage, the solenoid acts at once upon the rheostat, and it acts in a reverse direction upon a reduction of the voltage. The six-point rheostat at the lower left hand corner of Fig. 5 controls the resistance of the lamp circuit.

The following is a summary of the operation of the system. The train starts from a station with the main switch open and with no connection to the battery and no current through the solenoid. When the speed reaches 20 miles per hour, the limit generally used, the increased voltage closes the main switch and calls the solenoid into action. The armature of the solenoid then takes such a position as to cause the small motor to bring the arm of the rheostat into the proper position to bring the field resistance to the point required to secure the desired voltage, and it also places the necessary resistance in the lamp circuit to accommodate the increased voltage of the battery.

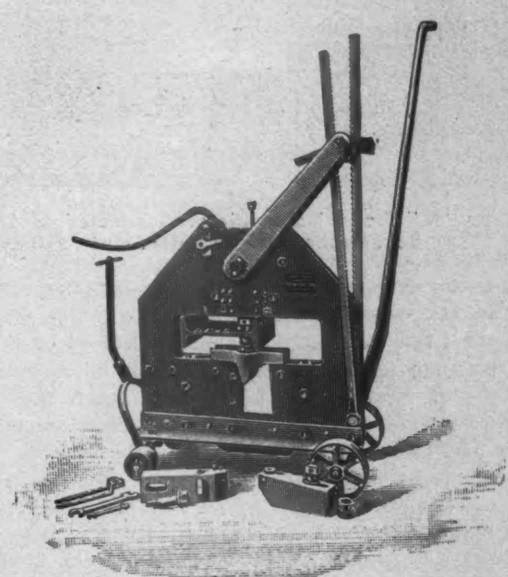
The car equipment of lamps and accumulators, and the adjustment of the machines, depends upon the requirements for lighting. The number of cells varies from 16 to 32, according to number of lights.

This system is now in use on a great many of the larger railroads of this country and Canada. The Columbia Co. have also put on the market, the Lihdstrom Lever Brake, which is used successfully on several styles of passenger cars, and is now being introduced for use on freight cars, on account of its safety feature.

THE WERNER PORTABLE HAND POWER PUNCH.

A number of convenient and powerful hand punches and cutters for punching and shearing plates and structural shapes have been designed and are manufactured by Henry Pels & Co., at the "Berlin-Erfurt Machine Works," Berlin, Germany. This firm is represented in the United States by Arthur Koppel, 68 Broad street, New York.

All the machines are similar in construction and operation to the punch which is illustrated by the accompanying engraving. The frame of the punch is made of plates riveted together and mounted on wheels for easy removal about the work. The opening in the frame admits the piece to be punched and serves to secure the backing for holding the work from below. A saddle, shown in the engraving, is placed under the work for supporting a plate or I-beam when the web is to be punched. For punching the flange this saddle is removed and the upper flange is supported upon the shoes seen lying on the ground in front of the machine. These are slotted at their outer ends to receive bolts by which they are secured to the frame. The punch is held on a bar with a vertical motion in guides placed between the frame plates. The curved lever serves to raise and lower it quickly to and from the work. The punch is driven by an eccentric placed over the head of the punch bar, and this is turned by means of the heavy twin levers seen in the engraving. A wedge is placed between the



The Werner Portable Hand Power Punch and Shear.

eccentric and the punch bar when the punch is ready and the twin levers are brought down by degrees by means of the long lever at the right and one of the ratchet rods which engage pawls on the ends of the twin levers. The second ratchet rod is secured to the frame and serves to hold the twin levers while the hand lever is raised in preparation for a return stroke. The working of the hand lever drives the punch or the shear through its work, slowly, but effectually. The machine illustrated has an opening of 36 inches to receive the work. It weighs 2,200 pounds and exerts a punching pressure of 320,000 pounds. This is sufficient to drive a 2-inch punch through a plate ¾ inch thick. These machines have been in use in Europe for about two years, with very satisfactory results. They are particularly well adapted for railroad work.

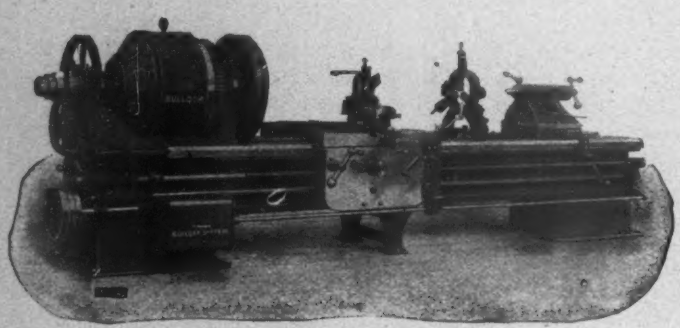
A $300 endowment of a room and bed in the Brooks Memorial Hospital at Dunkirk, N. Y., has been provided for in an appropriation by the Central Railway Club. This is a precedent which will be sure to find hearty approval.

A MOTOR-DRIVEN LATHE.

The Bullock Electric Mfg. Co.

The accompanying engraving illustrates a 28-inch swing, screw-cutting engine lathe, made by Messrs. Schumacher & Boye of Cincinnati, Ohio, driven by a Bullock "Type N" motor. The motor is placed directly on the spindle in the head stock, in the place usually occupied by the cone pulleys and the armature spider is built directly upon the hollow spindle of the lathe. The arrangement is attractively compact. It does away with the countershaft and belting, leaving clear head-room for cranes and permits of running a single machine or a group of them for overtime work without running long lines of idle shafting and belts.

The control of the speed of the lathe is a strong recommendation of this plan. By means of a new system of variable speed control, the motor is given a greater range of speed, without loss of power, than is ordinarily obtained by the cone pulley. It has sixteen speeds, in either direction, including the back gear. The controller is placed upon the leg of the lathe, directly under the head stock, and is operated by a splined shaft running along the bed of the lathe, and a handle which



Bullock Type "N" Open Motor Direct Connected to 28-Inch Schumacher & Boye Lathe.

travels with the carriage. The slowest speed is 60 and the highest is about 250 revolutions per minute.

These motors are the result of a great deal of experience which has been applied to the design with special reference to the production of machines which shall not require the attention of experts. They run cool without sparking, although the variation of load may be the full capacity of the machine. The brush holder mechanism which has been a constant source of trouble and anxiety has in this case been developed into a simple and highly efficient form, which is stated by those who use them to give no trouble or anxiety. This brush holder is of the reaction type, which does not necessitate adjustment of the brushes, and when once set, the motor will operate in either direction without sparking and under all variations of load.

This type of motor lends itself particularly well to the conditions of direct driving of machines. The machines are compact and they are made with either open or closed ends, the latter arrangement rendering the motor moisture and dust proof, and adapting it to service wherein an open motor would not be practicable. The "Type N" motor is arranged to be placed upon the ceiling, on the side wall or floor, and it may be either belted, direct-connected or geared to the work.

The motor is fully described in Bulletin No. 2435, which may be obtained by addressing the Bullock Electric Mfg. Co., Cincinnati, Ohio.

Press dispatches state that the labor troubles at the Cramps' shipyards in Philadelphia have led to the decision to make very extensive use of pneumatic tools throughout the yards and shops. It is stated that contracts aggregating $50,000 have been awarded to the Chicago Pneumatic Tool Co., for riveters, hammers, drills and other compressed air tools, and that much more will be expended in this way.

THE SARGENT COMPANY'S NEW WORKS.

The model steel and iron foundry which is being built by the Sargent Company at Chicago Heights, in order to increase their facilities, will be occupied about the first of January. The iron foundry department will be moved from the present works at 59th Street to the new plant, where it will have nearly three times the capacity, and will be devoted exclusively to the manufacture of brake shoes, while the old works will be entirely devoted to the manufacture of open-hearth steel castings. The new plant consists of two separate buildings, with floor space 80 by 200 feet each, and connected at one end by a building used as the finishing department. One building contains the iron foundry, while the other is devoted to small steel castings. These steel castings were formerly made in crucible steel, but will be made by the Tropenas process, which is now being used in several plants in each of the steel manufacturing countries of Europe. The present output of the Sargent Company is 600 tons of brake shoes and 600 tons of steel castings per month.

Mr. Edward Sweeley, Foreman of the car shop of the Pennsylvania Lines at Columbus, O., is to go to Logansport as Foreman of the machine shops.

Mr. George J. Hutz has been appointed Division Master Mechanic of the Illinois Central at East St. Louis, Ill., to succeed Mr. A. C. Beckwith, resigned.

Mr. M. M. Richey has resigned as General Superintendent of the Chicago, Lake Shore and Eastern to accept a position with the Central of New Jersey, with headquarters at Mauch Chunk, Pa.

M. F. Eagan, Jr., formerly Superintendent of Motive Power of the Union Pacific, Denver & Gulf Railroad, died Nov. 5, at his home in Chicago. Mr. Egan was in the service of the Union Pacific system for over 25 years.

Mr. L. H. Shepard has resigned his position as Mechanical Engineer of the Philadelphia & Reading, to enter the service of the Sterlingworth Railway Supply Company, as their representative, with headquarters at Easton, Pa.

The stationery department of the Burlington has been removed from St. Joseph to Hannibal and consolidated with the general supply department of the system at this point, under Mr. C. A. How, General Agent of the road.

Mr. George H. Colket of Philadelphia has been elected President of the Huntington & Broad Top Railroad Company, to fill the vacancy caused by the death of Spencer M. Jenney. Mr. Colket has been a director of this company since 1890 and is well qualified to assume the duties of President.

Horace S. Smith, formerly Vice-President of the Illinois Steel Company, died at his home in Chicago, Oct. 17, aged 73 years. He joined the Joliet Steel Company in 1875, and through his efforts the Illinois Steel Company was organized. Mr. Smith was elected to the position of Vice-President, which he held until ill health caused him to retire.

Mr. John P. Neff has been promoted to the position of Foreman of the Chicago and Northwestern, at Waseca, Minn., succeeding Mr. H. Montgomery, who has been assigned to other duties. Mr. Neff graduated from Purdue University in 1895, since which time he has been with the above company and engaged in important work in connection with the shops in Chicago and at other points. Mr. Neff was one of the observers in the tests on stacks and nozzles reported to the Master Mechanics' Association in 1896.

GILBERT'S GAGE GLASS PRESERVER.

The Gilbert self-packing gage glass preserver is made of rubber, in the form shown in the engraving, and is designed to permit of packing gage glasses so that they will be perfectly tight and prevent the breakage while in service. This packing is applied without the use of a wrench, and the gasket itself allows for sufficient expansion and contraction. The glass does not come into contact with metal, but bears against the rubber. The gaskets are made in six sizes, from ½ to 1¼ inch. They are offered in confidence that they will greatly

Gilbert's Gage Glass Preserver.

reduce the breakage of glasses, which is a source of danger to enginemen and firemen. Another advantage of this device is the ability to pack gage glasses in fittings which are not perfectly in line, and make them tight without danger of breaking the glass. We have seen a number of statements by those who have used the gaskets expressing entire satisfaction with them, and prominent mention is made of the fact that the glasses are made tight by screwing the packing nuts down with the fingers. This is a recommendation which will be appreciated by every steam user. These gaskets are made and sold by R. F. Morse, 33 Eddy Street, Providence, R. I.

PNEUMATIC TOOL PATENT LITIGATION.

It is not strange that the rapidly increasing business in pneumatic tools should be accompanied by conflicts as to the rights covered by the important patents. Such a result has been foreseen, and we are not surprised to receive the following statement from the Chicago Pneumatic Tool Company of Chicago relating to past and impending litigation:

The Chicago Pneumatic Tool Company, manufacturers of the well-known Boyer pneumatic tools, scored an important victory last month in its patent litigation with the American Pneumatic Tool Company of New York. Between three and four years ago the American company brought suit at New Haven, Conn., against a concern which was using one of the Boyer tools, and succeeded in obtaining a preliminary injunction on the strength of an old decision it had obtained sustaining its patent in a prior suit which had not been strongly defended. Upon obtaining this preliminary injunction the American company sent every concern using Boyer tools a notice of infringement, in which it claimed some two millions of dollars damages against the users of Boyer tools. The Boyer people promptly took an appeal from the preliminary injunction order, and the order was reversed by the Court of Appeals at New York City. This was about three years ago, since which time the suit has been progressing toward a final hearing on its merits. It was argued at great length before Judge Townsend, in the United States court at New Haven, last June, and has been held under advisement by the court until last week, when Judge Townsend handed down an exhaustive opinion, holding with the Boyer people on every point and declaring that the Boyer tools did not infringe the American company's patent. The court also took occasion, in its opinion, to condemn the conduct of the complainant company in sending out the circulars above referred to for the purpose of scaring and intimidating purchasers of the Boyer tools.

During the years this litigation has been pending numerous competitors of the Boyer tools have sprung up, many of which are closely copied after the Boyer tools and are claimed by the Boyer people to be infringements of the Boyer patents. Having successfully defended themselves against the attacks upon their tools, the Boyer people now propose to turn their attention to infringements of their own patents, and on Saturday last began suit in the United States court at Chicago against the Standard Pneumatic Tool Company, manufacturers of the "Little Giant" pneumatic tools. The Chicago Pneumatic Tool Company having been the pioneer in introducing pneumatic tools into railroad shops and metal working fields generally, and its Boyer tools having been the first successful tools for this work, is determined to protect the large business it has built up, and announces its intention of vigorously prosecuting all imitations of its Boyer tools and infringements of its patents.

An unusually large fill has been made on the Burlington. On the Deadwood, S. D., branch is a gulch 700 feet wide, known as Sheeps Canyon. This was crossed, until recently, by a wooden bridge, 126 feet high, which took over 240,000 feet of lumber in the building. Recently this trestle was filled in. It took twenty weeks to accomplish the task. It was necessary to haul 2,880,000 cubic feet of earth one and one-half miles up a two per cent. grade and unload off the high bridge. This required 1,486 trains of fifteen cars each; 22,000 carloads in all. The costly maintenance of the high trestle is saved and the serious danger of its destruction by fire avoided, thus warranting the expensive work.

Paper has found a new use in England in the manufacture of ropes for power transmission, and, contrary to what would naturally be expected, it seems to be very successful. "The Engineer" prints a description of paper ropes, and states that they are remarkably flexible and soft, seem to wear well and are satisfactory for purposes where specially high tensile strength is not necessary. They may be spliced and are composed of three main strands instead of four, as is customary in making cotton driving ropes. A case is cited in which a paper rope had been in continuous service for 18 months without perceptible wear, the surface being hard and shiny.

The pneumatic switch and signal system for the new southern union terminal station in Boston is supplied with compressed air by two stationary air compressors, and recently the adaptability of Westinghouse air-brake pumps for possible use in emergencies were determined by a test. Three locomotives were used and the air-brake pumps had no difficulty in supplying the pressure necessary to operate the plant.

BOOKS AND PAMPHLETS.

"Stories of the Railroad." By John A. Hill. Published by Doubleday & McClure Company, 141 East Twenty-fifth street, New York, 1899. Price, $1.50.

Nine stories, some of which were written ten years ago, and all having appeared in the pages of "Locomotive Engineering" or the popular monthly magazines, have been brought together in this book, which has been so successful as to go at once into a second edition. The stories are of the railroad and railroad men. They take the reader into the work of the locomotive engineer and into his home and recreations and his love affairs. The author's knowledge of the life he describes was obtained in it as a fireman and engine runner in the West. There is always a fascination about railroad experiences when told in an entertaining way, and the popularity of this work is easily understood.

Heat and Heat-Engines. A Study of the Principles which underlie the Mechanical Engineering of a Power Plant. By F. R. Hutton, E. M., Ph. D., Professor of Mechanical Engineering of Columbia University. 553 pp., illustrated; cloth. New York: John Wiley & Sons. Price, $5.

This book supplements an earlier one entitled "The Mechanical Engineering of Power Plants," by the same author, the object of which was to treat the steam engine and boiler with their accessories in such a way as to direct students to make use of them intelligently to meet the conditions of practical problems. That work did not consider the subject of design, this being left to the present one, the preface of which contains the following statement concerning its scope:

It discusses the energy resident in fuels, and the methods of its liberation as heat for power purposes; the transfer of such heat to convenient media whereby it can be used in heat-engines; the laws and properties of such media, and the design of cylinders of the necessary volume to give a desired mechanical effect or horse-power. Then, this point having been

reached, and relations being established for the mutual variations of temperature with pressure and volume in such media when operated in a cylinder with a piston, it becomes easy and natural to go further and discuss the air-compressor and its complement, the air-engine; and to extend this discussion to include the problem of mechanical refrigeration. The hot-air engine using a permanent gas as a medium naturally leads to the gas-engine and the oil-engine; and the engine using steam as a medium leads naturally to those using other media, such as naphtha, alcohol, and ammonia. The chapter on the Injector as a heat-absorbing and energy-transforming device closes the book.

The author undoubtedly desired to cover as much ground as possible in this work, which is commendable. The injector and mechanical refrigeration are interesting and important subjects, but they appear, however, to be a little out of place here, if we understand the author's purpose. The amount of space given to the various subjects attracts attention, and in future editions this may possibly be changed somewhat. For instance, 20 pages and 13 engravings are devoted to hot-air engines, and only four pages and three engravings to the steam turbine, which has every appearance of being one of the most important of recent improvements in steam engineering.

In these days of rapid progress in mechanical matters most text books are out of date almost immediately after coming from the press, and it is almost impossible to write a book that is up to date in which much attention is given to specific devices, because book-writing and publishing are slow processes. The author's excellent presentation of the theory of heat in heat engines is commended. One needs the calculus to follow the text closely, but those, like the reviewer, who have become very rusty in its use, may read with comfort and understand the discussion. It has been recently said that "Thermodynamics is a subject to be approached only after a preparation of fasting and prayer, and then only in the hallowed seclusion of one's own closet," (We are not sure of the accuracy of this) but Professor Hutton has made it possible to get a better and clearer view of the subject than we have seen before, and he has robbed the dreaded "Thermo" of some of its terrors. The book contains much practical information concerning fuels, combustion and steam and gas engine accessories; and a fair proportion of space is given to such subjects as the draft of steam boilers, stability and structure of chimneys, gas making and fuels.

The book has many good points and will be exceedingly helpful to students of engineering. It has an admirable index.

Proceedings of the Master Car Builders' Association. Thirty-third Annual Convention, Held at Old Point Comfort, Va., June, 1899. Edited by the Secretary, Joseph W. Taylor, 667 The Rookery, Chicago. 511 pages, standard size (6 by 9 in.).

This volume contains the lists of conventions, of officers, subjects and committees for the next convention, list of members with their addresses, the constitution and by-laws and a complete official report of the proceedings of the 1899 convention, including the reports of committees, the discussions, the result of the letter ballot on important questions, and a set of drawings of the revised standards and recommended practices of the association. These reports come in so regularly and so soon after the conventions that they are now taken as a matter of course and receive little if any comment. They comprise the most valuable literature on car subjects and are unique in containing the beginning, the discussion and the definite conclusion of subjects of the greatest importance in the development of the transportation of the country. The report at hand emphasizes the clean character of the work of this organization, which met last June and now, through the activity of the Secretary, has completed the adoption of every suggestion of importance that was submitted for discussion, and those suggestions are now placed before the railroads as standards or recommended practices of the association for use on roads representing a car valuation of $500,000,000. The association is not above criticism, but the impression of work carried out for a purpose and carried to completion which this report gives should not be lost. No new features are discovered in this volume except the changes made in accordance with the adopted recommendations with regard to revision of the former standards and the addition of new standards and recommended practices, which are very important this year. The volume appears somewhat later than the report of the Master Mechanics' Association, which is due to the letter ballots. In spite of this, the report comes more promptly than that of any technical association except the Master Mechanics'.

Jim Skeevers' Object Lessons on Railroading for Railroaders. By John A. Hill, President The American Machinist Press, and formerly one of the Editors of Locomotive Engineering. Published by The American Machinist Press, New York, 1899. Price $1.00.

This is a book of twenty chapters, each of which is devoted to a question in the operation or maintenance of locomotives. The author writes from the standpoint of one who has devoted some years of his life to living and working with the men who operate and maintain the American locomotive, and he has chosen a unique method of bringing necessary improvements before those whom he desired to reach. These chapters appeared in the columns of Locomotive Engineering and in them the interesting character, Jim Skeevers, rises from locomotive runner to Superintendent of Motive Power. The object lessons are those which he teaches, some times to his fireman and at other times to the other officials, going as high as the Vice-President. The book is full of sensible discussions which may be read with profit by many railroad officers other than those having direct charge of locomotives. The same amount of information might have been given in other ways, but the author's idea was to attach the story to the argument in order to impress the lessons which he desired to teach. Nothing like this book has ever been printed before and the information is presented in a very entertaining way, not the least value of which is to show the utter absurdity of manv features of the usual method of running a railroad. The book is full of slang and is probably true to life in this respect, but perhaps the author's object could not be secured in any other way. It contains many things that are worth remembering and we heartily commend it to our readers. Every motive power and operating officer ought to read it.

Notes on Mechanical Drawing. By Lucien E. Picolet, Instructor at the University of Pennsylvania.

In this little pamphlet the author has very carefully outlined the principles of mechanical drawings for the use of students in Mechanical Engineering at the University of Pennsylvania. He does not enter into detail, but rather sets forth the object, scope and methods to be carried out, in this course, which is as extensive and thorough as will be found in any of our technical institutions.

Cooking on Trains.—The Safety Car Heating and Lighting Co. have issued a handsome little booklet directing attention to recent improvements in Pintsch gas broilers used on parlor and buffet cars on the finest trains in the country. These devices have made it possible to obtain well cooked meats without the elaborate kitchen equipments of dining cars, and have been the means of greatly improving the meal service on buffet cars. These broilers are used on all of these cars on the New York, New Haven & Hartford, on such trains as the Empire State express of the New York Central, and the best trains of the Chicago & Northwestern and other equally important lines.

Westinghouse Railway Motors.—A pamphlet of 34 pages (6 by 9 in.) has been issued by the Westinghouse Electric & Manufacturing Co., Pittsburgh, devoted to the illustration and description of the railway motors manufactured by them and supplemented by several illustrations of typical Westinghouse railway power stations. The motors shown have all been subjected to the test of service operation. Attention is directed to the tendency of the past toward the use of motors having insufficient power and also to the importance of providing for the rise of temperature in the fields of motors of this type. Both of these points are provided for in the product of these works, and the ventilated armature has reached a high state of development. The use of laminated poles is continued. Their standard motors range in capacity from 20 to 150 horse-power, embodying the experience of the past 10 years. The engravings in this pamphlet are worthy of special note for their uniform excellence.

Transactions of the American Institute of Mining Engineers, Vol. XXVIII., February, 1898, to October, 1898, Inclusive.

This volume contains a list of officers and honorary members, a list of meetings, the rules and the proceedings, including papers and discussions of the annual meeting of the American Institute of Mining Engineers, held at Atlantic City in February, 1898, and the Buffalo meeting in October, 1898.

Wayside Notes Along the "Sunset Route."—The Southern Pacific Company has issued a number of exceedingly attractive pamphlets prepared by Mr. E. O. McCormic, Passenger Traffic Manager, and Mr. T. H. Goodman, General Passenger Agent, the best of which bears the title given above. The purpose of this pamphlet is to anticipate questions which the traveler desires to ask while he journeys. It is a guide book to the country passed through on the line of the Southern Pacific Company's "Sunset Route," and names the rivers and mountains and gives information concerning specially interesting scenes, giving facts such as altitudes and population, and pointing out many interesting places which would otherwise be passed by in ignorance of their existence. The traveler wants to be recommended to hotels and a part of the purpose of the pamphlet is to meet this requirement. The right hand half of every alternate page bears four well executed half-tone engravings. They are small but well photographed and well selected. The effect of an examination of it is to create a strong desire to see the places described, which is the test of a publication of this character. This is the best work of this kind that ever came into this office, and readers are recommended to secure copies.

"The Standard Scales." A copy of the fifth edition of the illustrated catalogue of scales, issued by the Standard Scale and Supply Company, 211 Wood street, Pittsburg, has been received. All who have occasion to use scales of any kind will do well to procure a copy. The variety of scales now regularly manufactured is surprising. We are told that the appearance of this catalogue is due to the large number of modifications of scales which increasing business has caused this company to manufacture. A specialty seems to have been made in weighing apparatus for railroads, for weighing coal, locomotives, cars and storehouse stock of various kinds. Among the special devices we notice on page 80 an illustrated description of the "Reed Recording Attachment," which seems to be a very convenient, simple and satisfactory device for obtaining a permanent record of the scale reading without stopping to note the position of the poise weight. A description of the attachment was printed in our November issue. Among the railroads using this device are the following: Chicago, Lake Shore & Eastern; Cape Fear & Yadkin Valley; New York, New Haven & Hartford; Southern; Louisville & Nashville; Great Northern; Long Island; Bellefonte Central; Pittsburg Junction, and the Alberta Railway & Coal Co. The appreciation of iron and steel manufacturers is shown by the fact that such concerns as the Midvale Steel Co., the Bethlehem Iron Co., the Lukens Iron & Steel Co., the Illinois Steel Co. and many others are using the device.

Ajax Products.—The Ajax Metal Co. of Philadelphia has issued a 32-page pamphlet describing Ajax productions and their uses. This firm manufactures six classes of specialties: I. Copper products for bearings, and including Ajax metal, red brass, yellow brass and acid metal. II. White metals; babbitts, solder, spelter, U. S. tin, Ajax tins and phosphor tin. III. Finished specialties, such as trolley wheels, trolley axles, contact pieces, controller fingers, Ajax Perfect rail bonds, armature motor and axle bearings. IV. Jewelers' specialties. V. Plat furnaces. VI. Ajax lead coated iron. The Ajax metal with which our readers are familiar is a composition of 77 parts of copper, 11½ parts of lead and 11½ parts of tin. It is an alloy prepared by a process developed by long study and experience which produces homogeneous distribution of the lead in such a way as to give support to the particles of this metal so that each will act as babbitt metal with a copper and tin shell. The important effect of this process was very clearly shown in the admirable paper by Mr. Guilliam H. Clamer, read before the Franklin Institute and reproduced in our issue of September, 1898, page 313. This paper is printed in the pamphlet before us and is accompanied by information concerning bearing metals under the titles: "Phosphor Bronze Compared with Ajax Metal," "Ajax as Compared with Similar Compositions," and descriptions of the various bearing compositions known by the name "Ajax." The engravings of the pamphlet are excellent. They include half-tones of several high speed locomotives and one of the American liner "S. S. St. Louis," which is equipped throughout with Ajax metal bearings.

"Drawing Instruments." A catalogue and price list of drawing instruments has been received from Theo. Alteneder & Sons, 945 Ridge avenue, Philadelphia. This is the eighteenth edition of the catalogue of this well-known firm and it contains engravings, descriptions and prices of all of their instruments which are the results of fifty years of efforts to perfect their design and construction. An introductory chapter contains a history of drawing instruments of the American pattern, which began in 1849, when Mr. Theodore Alteneder introduced the improvements which have made the name of this firm a guarantee of excellence. The pamphlet has 114 pages, with an index.

"Pneumatic Tools." A catalogue of the "Monarch" pneumatic tools has been received from the Standard Railway Equipment Company of 210 Vine street, St. Louis, and 706 Great Northern Building, Chicago. The pamphlet illustrates the pneumatic hammers and portable drills manufactured and sold by this firm and their application to various kinds of locomotive and car building and repair work. The engravings are excellent half-tones, giving a clear idea of the construction and operation of the tools. The tools described are the "Monarch" pneumatic hammer and "Monarch" drills, for metal and wood. The piston air drill No. 1 will drill holes up to a diameter of 2¼ inches in metals. No. 2 is for wood boring and will bore holes up to 2½ inches diameter in oak. No. 3 will bore holes up to 1⅛ inches in oak, and the piston air drill No. 4 will drill holes up to 1½ inches in metals. The machines are light in weight and convenient in size.

"Improved Machine Tools." Messrs. William Sellers & Co. of Philadelphia have issued a new catalogue and general description of improved machine tools for metal working as designed and manufactured by them. The product of these works is so well known that it is not necessary to enumerate the various lines of machines. It is sufficient to say that the entire field of machine tool construction is represented and that anyone desiring machinery for metal working will find his needs provided for, and the engineering department in which the designs have been produced is constantly engaged upon the work of improvement in the regular product as well as upon the details of special construction which are required to meet individual conditions. The works are continually developing new machines and the present catalogue could not be complete for this reason. It includes as many as possible of the machines which have been added to the list since the appearance of the previous catalogue and those shown have in many cases been revised and improved upon former standards. This volume is intended to indicate the general line of work of these builders and it accomplishes this object admirably. If, however, intending purchasers do not find their requirements provided for in the machines which are illustrated, they may find that the concern has exactly what is wanted in the large number of machines which are not included. The needs of railroad and locomotive building shops have been studied with great care in many special tools. The lines of tools indicate that the designers have in mind the principles of low cost of manufacture by use of their machines because a large number arranged for multiple working are included. Testing machines of the Emery type, large cranes and locomotive turntables indicate some of the specialties which the company is prepared to supply. We do not attempt to give the whole list, but it may justly be said that this is a most excellent treatise on up-to-date machine tool construction, in which the engravings are uniformly excellent and the text gives a generous amount of information of the sort required by a prospective purchaser. The book represents the best construction of machines from small bolt and nut screwing machines up to eight-foot turning and boring lathes for 16-inch cannon and rotary planers for armor plate. The catalogue is every way creditable to the leading machine tool builders of this country.

Architect's Hand Book On Cements. By William W. Clarke & Son.

This little book of 96 pages contains a collection in convenient form of information concerning the proper use of cements, and gives a number of specifications and formulas for mixing and using cements as recommended by leading authorities. It includes the history of cements in brief, discussions of mixing, testing, the selection of sand, notes on cement concrete, sidewalks and floors, and a short list of books on cements and concrete. The latter half of the pamphlet is devoted to advertising. The address of Wm. W. Clarke & Son is 115 Gay Street, S., Baltimore, Md.

Mr. G. J. Fisher has resigned as Purchasing Agent of the Fitchburg Railroad.

C. F. Hettler, Purchasing Agent of the Pennsylvania Lines, at Fort Wayne, Ind., died in that city November 6.

Mr. Robert T. Lincoln, heretofore Chairman of the Executive Committee of the Pullman Palace Car Company, has been elected President, and Mr. T. H. Wickes was re-elected Vice-President.

Mr. J. B. Laurie has been appointed Purchasing Agent and General Storekeeper of the Central Vermont, with headquarters at Saint Albans, Vt., to take the place of Mr. W. B. Hatch, whose title was General Purchasing Agent.

Spencer M. Jenny, President of the Huntington & Broad Top Mountain Railroad, died very unexpectedly, Oct. 21, at his home in Philadelphia, of heart failure. Mr. Jenney was 61 years old, had been President of the above road since April, 1890, and was also a director of the Choctaw, Oklahoma & Gulf Railroad and of various financial concerns.

Mr. George R. Brown, for many years General Superintendent of the Fall Brook Railway prior to the transfer of the company to the New York Central, has been elected Second Vice-President and General Manager of the New York & Pennsylvania, a road running south from Canisteo, N. Y., into Pennsylvania. Mr. Brown was the originator of the "Brown's Discipline" and author of the article "Discipline and Education of Railway Employees," "American Engineer," February, 1899.

EQUIPMENT AND MANUFACTURING NOTES.

Electric headlights have been adopted on the Chicago, Burlington & Quincy for the fast mail and the Denver limited trains.

The Q & C Co. inform us that Mr. E. W. Hodgkins has sailed for an extended trip through Europe in their interests. Mr. J. K. Lencke, who has been abroad for this firm since January 1, has been recalled and is no longer in their employ.

The Baltimore & Ohio Railroad will have 62 new compound consolidated freight locomotives by the last of January. Fifty were ordered in September from the Baldwin Locomotive Works and the order has just been increased by 12 more.

The International Correspondence Schools of Scranton are making use of stereopticons in two of their instruction cars for the assistance of students in the railroad courses. The lectures are given by Mr. A. C. Beckwith, who was formerly Master Mechanic of the Illinois Central at St. Louis and who has taken charge of this branch of the work of the schools.

The Union Boiler Tube Cleaner Co., 253 Penn Ave., Pittsburgh, have just completed a contract for cleaning two Hazelton, or porcupine, boilers having 2,000 tubes, one end of each tube being welded tight. These tubes were badly scaled and the cleaning of the closed end required a special tool of unique design. The work also required the use of the special flexible shaft designed by this firm, which is the only concern in this country properly equipped with apparatus and expert operators for doing such work quickly, effectively and cheaply.

The Bullock Electric Mfg. Co. report 55 orders for the month of October, the machines ranging in size from the smallest to 300 kw. capacity. A repeated order was received from the Maryland Steel Co. of Sparrows Point, Md., this making the fifth order and being for a 300 kw. generator and several motors. Orders were received from the London (England) "Star" and St. Petersburg (Russia) "Novia Wremia," two of the most important papers of the respective cities, for the Bullock "Teeser" equipment for operating newspaper presses. Two 300 kw. alternating current generators were shipped to the Wilson Aluminum Co. of Holcombe Rock, W. Va., to be used in the manufacture of ferro-chrome, an electro-chemical product used in the manufacture of chrome steel.

The Cling-Surface Manufacturing Co., of Buffalo, N. Y., report steadily advancing demand from belt users for "Cling-Surface," including several large shipments to Mexico and England. Unsolicited testimonial letters are being received every day from customers of this concern, one of which from Adams & Westlake Co., of Chicago, says: "We have been using Cling-Surface for some time and it gives perfect satisfaction." The Erie R. R. Co., Union Dry Dock, of Buffalo, said on March 2, 1896: "Our power has been increased very considerably, the belts are soft, pliable and in simply perfect condition; it has earned many times its cost." On Oct. 20, 1899, they again say: "We have not a tight belt in the shop, and are better satisfied than ever with Cling-Surface."

Announcement is made of the organization of the New York Air Compressor Company under the laws of the State of New Jersey. The capital stock of the company is $100,000, and a complete foundry and machine shop plant has been purchased on the line of the New York & Greenwood Lake Railroad at Arlington, N. J. Contracts have already been let for a complete modern equipment of tools. It is intended to manufacture a complete line of air compressing machinery at the new plant. The officers of the company are: J. W. Duntley, President; Alexander MacKay, Vice-President; W. P. Pressinger, Secretary and Treasurer. The directors are: J. W. Duntley, Alexander MacKay, W. P. Pressinger, William B. Albright, W. O. Duntley, Thomas Aldcorn and Austin E. Pressinger. The New York offices of the company are at 120 Liberty Street.

An interesting statement in regard to the use of Pearson jacks comes from Mr. F. E. Paradis, Chief Engineer Chicago Terminal Transfer R. R., as follows: "We used eight of these jacks in connection with other jacks, in moving our 600 ton drawbridge. We used Pearson jacks exclusively to start the bridge on the ways, and used them at various points on the structure in raising and lowering it. While the bridge was being lowered, on account of the carelessness on the part of the man who was operating one of the Pearson jacks, the thread ran in, thereby closing the two ends tightly against the center. It was not noticed until the jacks around it had been lowered considerable, and bound the Pearson jack fast. We then placed four 35 ton hydraulic jacks at four points around the Pearson jack and attempted to release the load upon it, but were unable to do so. If each of the hydraulic jacks were lifting their full capacity, and I have every reason to believe that they were lifting more than their stated capacity, there was at least 150 tons on this jack. It seemed impossible to release it, and I gave instructions that the jack be broken with sledges. After hammering on it for some time it was found impossible to break it. It was necessary to cut the blocking out from underneath by a small piece at a time to release it." These jacks were furnished by the Pearson Jack Co., 64 Federal St., Boston, Mass.

The Pennsylvania Railroad has ordered 80 new locomotives to be built at the Juniata shops. Of these, 43 are Class G 4-A and 27 Class G 4. These classes are freight moguls, the former having 68-inch and the latter 62-inch driving wheels; otherwise the designs are alike. They will have Belpaire boilers with 356 flues, 2,814 square feet of heating surface and 30.8 square feet of grate area, and will carry a steam pressure of 225 pounds per square inch. The cylinders are 20 by 28 inches and arranged like those of the H 5 and H 6 engines illustrated in our June issue of the current volume, the cylinders being separate from the saddles. This practice appears to be likely to become standard on this road for the reasons stated in the description mentioned. The front frames are of cast steel and made in the form of slabs. The engines will have single steam pipes, like the Class E 1 passenger engine. These types are new and these are the first to be constructed.

Since the above was written, information has been received to the effect that the order had been increased to 113 locomotives, of which 35 will be Class G-4; 55, Class G 4-A; 13, Class L, and 10, Class H-6.